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OF THE

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SUMMARY

The outstanding event of 1955 in connection with atomic energy development was the International Conference on the Peaceful Uses of Atomic Energy which was held in Geneva, Switzerland August 8 to 20. Originally proposed by the United States and later sponsored by the United Nations, the Conference brought together scientists and engineers of 73 nations to discuss almost every facet of the subject. There were extensive Governmental and commercial exhibits. The first chapter of this report summarizes this Nation's participation in and the results of the Conference.

There were many other noteworthy developments in the Atoms-for-Peace program of the United States and cooperating nations during this reporting period. The growing pace of action required the creation of a new Division of International Affairs to provide organizational arrangements to help handle the Commission's part in the program.

Events of the 6 months[1] included: completion of cooperative agreements between the United States and 22 other countries on peaceful applications of atomic energy (5 others were pending as of December 31); steadily increasing international exchange of technical information on various phases of atomic developments; progress in the establishment of an International Atomic Energy Agency; and announcement by the Commission of a price for enriched uranium leased to cooperating nations under bilateral agreements (along with sales prices for normal uranium and heavy water).

While moving forward with the international Atoms-for-Peace program, the Commission continued its domestic activities at an accelerating pace. The pattern was formed for further AEC provisions to encourage private enterprise in the development of an atomic energy industry, and for applying the necessary regulations and licensing arrangements under the Atomic Energy Act of 1954. Proposed regulations were published in the *Federal Register* for public comment, and the regulations themselves are being issued as soon as completed—the first in January 1956.

A constant flow of applications for access permits from a wide variety of industries, trades, and professions testified to the interest of private organizations and individuals in obtaining access to restricted data on civilian uses. An accelerated program of reviewing Commission reports and other papers useful in civilian applications and declassifying or downgrading whenever possible was entered upon.

[1] This report notes certain events that have occurred subsequent to the reporting period.

At the same time the program for publishing material available to industries and individuals in the civilian application program was greatly stepped up. Seminars and other meetings were held with representatives of companies interested in getting into the processing or production of selected atomic energy materials.

Domestic uranium ore and concentrate production continued to rise, maintaining this Nation's position as one of the world's leading uranium producers. Further foreign expansion in production will result from the operation of new ore processing facilities under construction in the Union of South Africa, and in Canada. Increases in domestic ore reserves, on the Colorado Plateau and elsewhere, were again reflected by the greatly expanded exploration activity of private industry. Research and process development studies on economic methods for recovery of uranium from its ores continued.

Production of various special nuclear materials during the last half of 1955 equalled or exceeded the quantities produced during the first half of that year.

In November, AEC refused recognition of the contract with the Mississippi Valley Generating Co. This report enumerates the steps taken by the Commission with respect to this contract during the reporting period.

Construction of the gaseous diffusion facilities at Portsmouth, Ohio, was ahead of schedule as the last building neared completion. Construction of additional feed materials processing facilities which began last March at Fernald, Ohio, St. Louis, Mo., and Paducah, Ky., is underway.

On October 27, the Commission announced it would accept up to October 1, 1956, proposals from industrial concerns for the manufacture of uranium feed materials.

Construction activity continued to be concentrated on production plant facilities. However, with the shift in emphasis to constructing reactors of civilian and military significance, activity in this area is gradually gaining momentum and is expected to become increasingly important in the construction program.

Largely as a result of progress in the construction of plant facilities capital investment in atomic energy plant facilities was estimated to have reached about $6.64 billion before depreciation reserves.

Analyses of the results of Operation TEAPOT, the test series conducted at the Nevada Test Site in the spring of 1955, opened up several new and promising avenues for research and development which could strengthen materially the defenses of this nation and the free world. Research and development during the last half of calendar year 1955 proceeded on an expedited basis, both for these new approaches and for those established by earlier study and test.

On January 12, 1956, the Commission and the Department of Defense jointly announced that preparations were underway for a series of nuclear tests to begin in the spring at the Eniwetok Proving Grounds. The text of the announcement and of a supplementary statement by Chairman Lewis L. Strauss appear on pages 38 and 39 of this report.

The Commission's program of developing reactors for industrial and military power and for naval and aircraft propulsion made significant progress. In September the Commission issued its second invitation under the power demonstration reactor program for proposals to develop, design, construct and operate power reactors ranging from 5,000 to 40,000 kilowatts of electrical capacity to demonstrate the practical value of such units for commercial use.

Emphasis continued on development of advanced power reactor technology through a number of experimental reactor projects. In this program four reactors are now under construction, three of which are scheduled to be completed in calendar year 1956, and the fourth in 1958. Construction of a fifth is scheduled to start in 1956. In addition, 4 new small reactor experiments are underway to explore other promising reactor concepts.

In the field of military reactor development, the USS *Nautilus*, powered by the Submarine Thermal Reactor, Mark II, steamed more than 25,000 miles and the reactor continued to operate satisfactorily. Development work for a boiling reactor to produce about 200 kilowatts of electricity was begun as part of the Army program. Prospects for nuclear powered flight continued to show promise.

The Engineering Test Reactor, a major tool for the development of all types of reactors, advanced to the architect-engineering stage. The ETR—in purpose a companion to the Materials Testing Reactor—is to be built next to the MTR at the National Reactor Testing Station.

Following a survey which defined the shortage of nuclear engineers, the Commission announced its first summer short course in reactor technology for college faculty members. Waiver of certain charges for fuel for reactors for educational institutions was also announced.

Substantial progress was made in the construction of the nation's first large-scale (60,000-kilowatt) civilian nuclear powerplant—the Pressurized Water Reactor at Shippingport, Pa. Westinghouse Electric Corp. is developing, designing, and fabricating the nuclear portion of the plant; Duquesne Light Co. is building the conventional portion of the plant and will operate the entire plant upon completion.

The physical research program continued to make significant contributions to fundamental knowledge of atomic energy and related sciences. As a result of these recent accomplishments the horizons for future research have been widened.

Significant progress was made in the use and development of accelerators for research in high energy physics. The antiproton was discovered as a result of research performed with the bevatron. The 86-inch cyclotron at the Oak Ridge National Laboratory demonstrated that many interesting radioisotopes can be produced economically and in large quantities. The technique of studying magnetic deflection of fine beams of atoms has been so perfected that it has become possible to determine the magnetic properties of the nucleus even for radioactive atoms. A major research effort (Project SHERWOOD) is underway in a long-range program to develop the controlled release of energy from atomic fusion.

In the biology and medicine program the effects and uses of radiation continued under study by the Commission at its National Laboratories as well as by a large group of investigators working at Commission facilities or in the laboratories of universities, colleges, hospitals, and other research institutions.

As more and more data have been obtained it has become possible to utilize radiation beneficially in an increasingly wide variety of fields. These research studies are also supplying information which will lead to perfecting methods of protection against the harmful effects of radiation—a most important consideration in view of the increasing use of atomic energy for industrial purposes. This report gives examples of kinds of research underway and the practical applications of such research.

"Operation ARME" (an aerial radiological monitoring exercise) was conducted at the Nevada Test Site by the AEC during the week of October 17, for Federal Civil Defense Administration-sponsored personnel. Successful completion of this exercise demonstrated the technical feasibility of aerial radiological survey techniques.

In the field of community operations, the Atomic Energy Community Act of 1955 was signed by the President on August 4. The Act provides for the disposal of Federally owned properties at Oak Ridge, Tenn., and Richland, Wash., and prescribes a basis for the establishment of self-government by the residents of these communities.

The financial report of AEC for fiscal year 1955 (Appendix 8) contains more detailed financial information than the Commission has made public previously. It includes summaries of costs for the years 1950–55 inclusive in the major AEC program activities.

On October 10, in a recess appointment, the President named Harold S. Vance to fill the existing vacancy on the Commission.

In the staff, Dr. Charles L. Dunham, formerly Deputy Director, Division of Biology and Medicine, was appointed Director of the Division replacing Dr. John C. Bugher who will continue to serve the

Commission on the Advisory Committee on Biology and Medicine. Charles L. Marshall, formerly Deputy Director, Division of Classification, was appointed Director of the Division replacing Dr. Charles D. Luke, who was appointed Technical Assistant, Reactor Hazards Evaluation. John A. Hall, formerly Director, Office of International Affairs, was appointed Director of the newly established Division of International Affairs.

Kenner F. Hertford was appointed Manager, Santa Fe Operations Office, replacing Donald J. Leehey. James E. Travis succeeded David F. Shaw as Manager, Hanford Operations Office. Mr. Shaw was transferred to Washington, D. C., as Assistant General Manager for Manufacturing.

Part One

U. S. Participation in the International Conference on the Peaceful Uses of Atomic Energy

U. S. PARTICIPATION IN THE INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY

Outstanding among activities during the last 6 months intended to forward the President's Atoms-for-Peace program was United States participation in the International Conference on the Peaceful Uses of Atomic Energy, convened by the United Nations in Geneva, Switzerland, August 8–20, 1955. The Conference was initially proposed by the United States, and the United States Delegation,[1] took a leading part in the work of the Conference.

The formal report to the Secretary of State, on behalf of the United States Official Representatives states, "Every indication points to the conclusion that the Conference must be regarded as an unqualified success. The statements of the delegates of the 73 nations represented, and of the heads of states who sent messages there, the interest of the public, and the comments of the news agencies throughout the world, all support this judgment. It is equally the considered consensus of the Official Representatives of the United States and their advisers."

The 73 nations plus the eight specialized agencies of the United Nations represented at Geneva sent to the Conference a total of 1,428 delegates of whom 327 were accredited by the United States. In addition to 902 representatives of the news media of the world, there also were 1,334 official observers, principally from nongovernmental organizations, academic institutions and industrial concerns.

The volume of scientific and technical information exchanged is evidenced by the fact that the United Nations has announced that 16 volumes will be required to publish the Conference proceedings. Twenty-three nations and four United Nations agencies submitted to the Conference a total of 1,067 scientific and technical papers, of which the United States contributed 512, or about 48 percent of the total. From all the papers, the United Nations selected 450 papers for oral presentation and discussion at the Conference, of which 176 were United States papers, or 39 percent of the total.

According to the Chairman's report, "the quality of the papers submitted, and the discussions of the papers, matched the best scientific

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[1] The United States Official Representatives (as listed in the Eighteenth Seminannual Report) were: Lewis L. Strauss, Chairman AEC, Chairman; Willard F. Libby, Commissioner AEC, Vice Chairman; Detlev W. Bronk, President National Academy of Sciences, and President Rockefeller Institute for Medical Research; Isidor I. Rabi, Chairman, General Advisory Committee, AEC, Higgins Professor of Physics, Columbia University; Shields Warren, Scientific Director, Cancer Research Institute, New England Deaconess Hospital.

General view of the opening session of the International Conference on the Peaceful Uses of Atomic Energy, meeting in the Assembly Hall of the Palais des Nations in Geneva, Switzerland. The photograph is taken from the right of the speakers' rostrum.

forums. The discussions among delegates were deemed generally free and frank. The spirit of cooperation and friendliness among delegates of all the Nations represented at the Conference was entirely in harmony with that engendered a few weeks before in Geneva during the Conference of President Eisenhower with the Prime Ministers of France, the Union of Soviet Socialist Republics, and the United Kingdom."

The report continued:

> "The measure of the Conference's success in all these particulars was the unanimity of response to President Eisenhower's expressed hope . . . that another international conference on peaceful uses of atomic energy could be held within two or three years. Prime Minister Bulganin of the USSR later made a similar suggestion in a formal message sent to the Conference closing session. Secretary General Dag Hammarskjold in his report on the Conference to the United Nations General Assembly on September 14, 1955, stated that the President of the Conference, Homi J. Bhabha, of India, had found that there was 'Universal sentiment . . . for another scientific conference . . . to carry forward the

work so well begun.' It is gratifying to be able to report the conviction of the United States Official Representatives that this Conference has made a genuine contribution toward opening the way for world-wide cooperation to place atomic energy at the peaceful service of all nations. President Eisenhower's leadership in this broad effort was generously praised. Speakers at the Conference referred repeatedly to the President's address before the United Nations General Assembly on December 8, 1953, in which he declared: '. . . The United States pledges before you—and therefore before the world—its determination to help solve the fearful atomic dilemma . . . to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life.' "

Pattern of Conference

The agenda of the Conference, held in the United Nations European headquarters, the Palais des Nations, on the outskirts of Geneva, was balanced between plenary sessions on general subjects and concurrent sections on scientific and technical subjects. There were 8 half-days of plenary sessions and, partly overlapping with them, 52 technical sections, the latter generally held in parallel, simultaneous forums starting the afternoon of August 10 and continuing daily except Sunday, through the morning of August 20.

Plenary sessions dealt with such broad topics as future world needs for energy, the economics of atomic power, programs of international cooperation, and scientific education. The technical sections discussed research and power reactors; reactor therapy; reactor physics; fuel elements; fissionable products and their extraction; raw materials exploration and processing; waste disposal and health protection; radioactive materials in diagnosis and therapy, in industry and in agriculture; and production, handling, and use of radioisotopes.

In addition to the general and technical sessions of the Conference, a series of 10 evening lectures was given in which leading men of science from six nations discussed matters of general scientific or public interest. Nine nations presented technical exhibits at the Palais des Nations: Belgium, Canada, Denmark, France, Norway, Sweden, the Union of Soviet Socialist Republics, the United Kingdom and the United States.

An educational and commercial exposition was held simultaneously at the Palais des Expositions in downtown Geneva. This was not an official part of the Conference, but was under the auspices of the Swiss Federal Council, the United Nations, the State Council of the Republic and Canton of Geneva, and the Administrative Council of the

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The U. S. Official Representatives' bench at the Conference at an early session. Right to left, Chairman Lewis L. Strauss, Mrs. Laura Fermi, U. S. Conference Historian, Dr. Willard F. Libby, and (standing) Dr. John A. Hall.

City of Geneva. The Governments of France and the United Kingdom sponsored commercial exhibits. The United States sponsored an educational "Atoms-for-Peace" exhibit in connection with the independent participation by United States commercial and industrial organizations.

A program of documentary and technical motion pictures was presented daily in a small theatre at the Palais des Nations, rotating 21 films prepared in the four official languages of the Conference: English, French, Russian and Spanish. Canada presented two films, France two, Norway one, the USSR three, the United Kingdom five, and the United States eight.

The Conference was unique among international scientific forums in that it was the first to be held in which all phases of a broad field were covered, from fundamental biology and physics, to their applications in medicine, engineering, and industry.

U. S. Background and Organization of Conference

The International Conference evolved from earlier United States plans to hold a conference on peaceful uses of atomic energy to advance its Atoms-for-Peace program. The first public suggestion for such a conference was made by Chairman Lewis L. Strauss, of the Atomic Energy Commission, in an address on April 19, 1954, when he announced on authority of President Eisenhower:

> ". . . the President's intention to arrange . . . an international conference of scientists . . . devoted to an exploration of the benign and peaceful uses of atomic energy."

After the United Nations, on the motion initiated by the United States, undertook in December 1954 to sponsor the Conference, the Atomic Energy Commission was requested by the Secretary of State to undertake preparations for United States technical and scientific participation in the Conference and Chairman Strauss was asked to serve as Chairman of the United States Delegation. At Chairman Strauss' request, Dr. Isidor I. Rabi had been directing preliminary plans for the Conference since April 1954.

When Dr. Rabi became United States Representative on the United Nations Conference Advisory Committee, the Chairman selected, as director of United States technical preparations, Dr. George L. Weil, a consultant to industry, who had been closely associated with nuclear energy work since 1940, as an associate of Dr. Enrico Fermi, in the Manhattan District, and in the Atomic Energy Commission as Assistant Director of Reactor Development. Dr. Weil established within AEC, the Office for International Conference, which directed all preparations for United States technical participation in the Conference.

The United States Delegation to the Conference, plus the secretariat and staff, totaled 398 persons. The Official Representatives had eight Congressional Advisers, 192 technical and other advisers, and a secretariat and staff comprising 84 principals (including 9 of the advisers) and 118 others. The Congressional advisers, all members of the Joint Congressional Committee on Atomic Energy were: Senator Clinton P. Anderson, Chairman; Senator John O. Pastore, Senator Bourke B. Hickenlooper, Senator John W. Bricker, and Representative Carl T. Durham, Representative Chet Holifield, Representative W. Sterling Cole and Representative Carl Hinshaw.

Members of the United States Delegation named as Chairmen for the Conference Technical Sections were: Dr. J. C. Bugher, Dr. J. P. Howe, Dr. D. J. Hughes, Dr. W. F. Libby, Dr. Glenn Seaborg, Dr. F. H. Spedding, Dr. V. F. Weisskopf, and Dr. E. P. Wigner.

When the joint AEC-Department of State office was established on June 14, 1955, for actual conduct of the Conference, Dr. Weil headed the Office of Technical Programs and Exhibits, with Mr. T. O. Jones as Administrative Officer, Dr. Paul W. McDaniel as Technical Papers Officer, Dr. Alberto F. Thompson as Exhibits Of-

Congressional advisers to the United States Delegation at the Conference. In the row behind the United Kingdom bench (Royaume Uni), they are, left to right, Senator Clinton P. Anderson, Chairman, Joint Congressional Committee on Atomic Energy, Representative Carl T. Durham, Senator Bourke B. Hickenlooper, Representative W. Sterling Cole, Senator John W. Bricker, and Senator John O. Pastore.

ficer, and Dr. George G. Manov as Reactor Officer. Harry S. Traynor, AEC Assistant General Manager, became Executive Officer of the United States Conference Office with George M. Fennemore (State) as his deputy. The United States Delegation's Information office was under the direction of John P. McKnight (USIA), with Morse Salisbury (AEC), Joseph Hanson (USIA), and Richard Friedman (State) as deputies.

Other offices were: Liaison and Protocol, Dr. John A. Hall (AEC); Classification Office, Dr. Charles D. Luke (AEC) with Charles L. Marshall (AEC) as deputy; Administrative Office under Albert J. Ciaffone (State) with H. D. Anamosa (AEC) and G. R. Koontz (State) as deputies; and Special Services Office under the codirectorship of Daniel H. Clare, Jr. (State), and Bryan LaPlante (AEC) with K. O. Lynch (State) and R. G. Cavanaugh (AEC) as deputies.

U. S. Activities on Conference

Before and during the Conference, a number of news releases was issued. News conferences were held by Dr. Rabi at New York and Paris in May and by Chairman Strauss and Dr. Weil in June and July at New York and Washington; and by Dr. Weil in August at Geneva before the Conference opened.

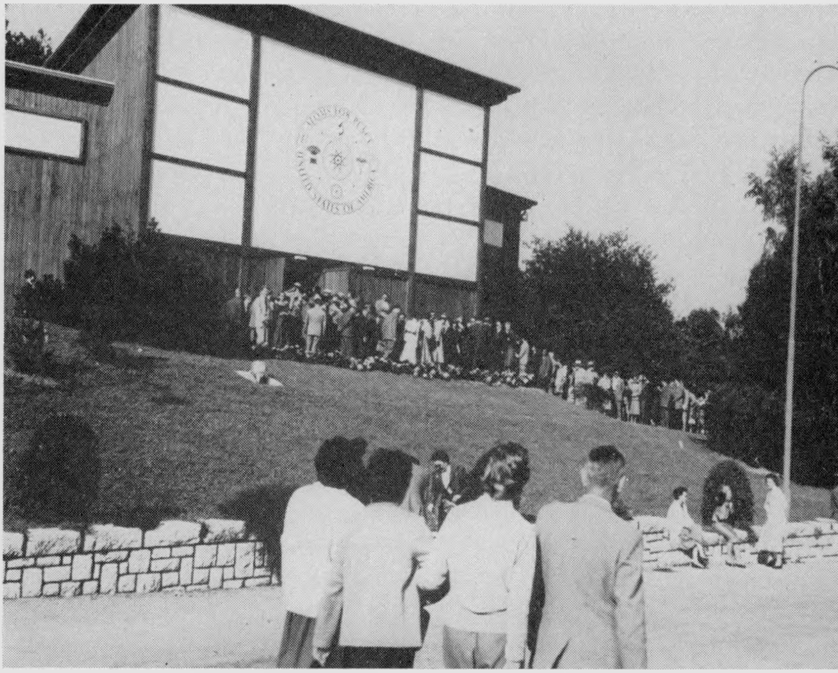
During the Conference, two press conferences were held by Chairman Strauss and Commissioner Libby. In the first, Chairman Strauss paid tribute to the Conference for "reopening lines of communication between men who have not been in communication for many years," and announced establishment by the Ford Motor Co. Fund of a $1 million fund to provide world-wide atoms-for-peace awards. In the second, Chairman Strauss discussed the prospects for thermonuclear power. He confirmed that the United States had a program in this field but counseled that "there has been nothing in the nature of breakthroughs that would warrant anyone assuming that this was anything except a very long range—and I would accent the word 'very'—prospect".

The United States took the occasion of the Conference to announce on August 8 its prices for lease of enriched uranium or sale of normal uranium and heavy water (see International Affairs).

One news release concerned the showing in Geneva of a motion picture on production of electricity by the Experimental Boiling Water Reactor, Borax II. The film, made especially for the Conference, pictured the town of Arco, Idaho—normally supplied with electricity by a conventional system—being lighted and powered experimentally for one hour with electricity from the reactor on July 17, 1955—the first American community to receive its entire supply of electricity from a nuclear reactor.

Early in the planning stages of United States participation in the Conference, AEC undertook to prepare an 8-volume set of selected reference material, a collection of technical unclassified and declassified information on various peaceful uses of atomic energy, together with a special introductory volume, which was printed in the four official languages of the Conference: English, French, Russian, and Spanish. An initial presentation of the introductory volume was made at a luncheon August 9 to the United Nations and Conference officers. The complete sets were made available to official representatives of all nations represented.

On the final day of the Conference, August 20, 1955, the United States presented to the United Nations a reference and depository library, part of the United States Technical Library Exhibit at the Conference, and similar to those that have been presented by the United States to other countries. On that day also, Chairman Strauss, acting on behalf of the United States, signed over to Paul Scherrer, Chairman, Swiss Commission for Nuclear Research, acting on behalf of the Swiss Government, the research reactor exhibited at Geneva which the Swiss had arranged to purchase.



Crowds waiting to enter U. S. Research Reactor Exhibit on grounds of Palais des Nations in Geneva. The reactor was located in the higher central portion of the temporary building which the United States erected to house the reactor. The front panel of the building displays the "Atoms-for-Peace" emblem.

U. S. Participation in Sessions

Paramount among the activities of the Conference in influence on world advancement in technical atomic energy knowledge—and therefore in realizing the objectives of the Conference—were the sessions, both plenary and technical, for the presentation of papers and discussion among the delegates. In the following paragraphs the United States participation in the sessions is noted in general terms.

The United States and all other nations presenting papers and engaging in the discussions both received and gave information. Evaluations of the Conference by United States technical men contain numerous references to new knowledge in nuclear theory and nuclear engineering which was derived from the contributions of other nations. One particularly useful aspect was the confirmation of considerable United States nuclear measurement data by independent research in other nations which was made public at the Conference.

Important contributions of this country included new data in such fields as geology of raw materials, ore recovery and processing, basic nuclear constants, neutron cross sections and in reactor design and development.

Plenary Sessions

United States Official Representatives spoke at two of the Conference plenary sessions. At the opening assembly when messages from chiefs of states were read, Chairman Strauss presented to the delegates a statement from President Eisenhower in which the President reaffirmed the pledge made before the United Nations General Assembly on December 8, 1953, that the United States would work for world progress in peaceful uses of atomic energy.

"The pledge which we gave 20 months ago," the message stated, "has become the law of our land, written into our statutes by the American Congress in the new Atomic Energy Act of 1954. The new Act states in forthright language that we recognize our responsibilities to share with others, in a spirit of cooperation, what we know of the peaceful atomic art. To further encourage such cooperation with other nations, the new Act relaxed the previously existing restrictions on independent atomic research and development by private industry . . ."

In pointing out that the scientists and engineers held the keys to "the bright promise of the benign atom," the President said, "No other scientific gathering of such scope and importance, or of such widespread interest, has ever taken place. The peoples of the world are represented. At hand is a rich opportunity to restore old lines of free scientific communication which have been disrupted for so many years. The knowledge and skills which each of you has acquired in his own country to put the atom to work for peaceful purposes will be circulated and shared in the friendly atmosphere of hospitable Switzerland with its age-old tradition of freedom."

In the closing session of the Conference, Dr. Willard F. Libby presented Conference paper No. 805, "The United States Program of International Cooperation for Peaceful Uses of Atomic Energy," in which he referred to the address of President Eisenhower on December 8, 1953, before the United Nations General Assembly, and the proposal that an international agency be established under the aegis of the United Nations. He told of the steps the United States already had taken toward international cooperation in advance of the formation of the international agency.

"Forty-seven countries now receive shipments of radioisotopes," Dr. Libby pointed out. "It is intended to facilitate this foreign distribution by an early substantial liberalization of the regulations applying.[2] For some time, the Oak Ridge Institute of Nuclear Studies has been offering a course in the handling of radioisotopes. In May of this year a special 4-week course began at Oak Ridge with 30 scientists and technicians from 21 nations in attendance . . . In the future, a substantial percentage of the total enrollment . . . will be reserved for students from countries other than the United States."

Dr. Libby mentioned other training courses offered in the United States which would be open to students from other countries, including one in reactor technology attended by 30 students from 19 countries, and went on to describe the technical libraries which the United States presents to nations that request them.

In telling about bilateral agreements of cooperation which the United States had signed with other nations, Dr. Libby stated that, under these agreements, "the United States aids in the construction of research reactors, will contribute half the cost of the first reactor in each country, and furnishes the necessary fuel for these reactors." He cited the President's allocation of 200 kilograms of enriched uranium for use in research reactors abroad.

"I should like to emphasize, " Dr. Libby said, "that each of these bilateral agreements states that it is the hope and expectation of both parties that the initial Agreement for Cooperation will lead to consideration of further cooperation extending to the design, construction, and operation of power reactors." He cautioned, however, that "for the next few years the atom will not be a major source of power . . . It is the aim of the United States to help other countries proceed, as rapidly as possible, toward the economic production of electric power from the atom . . ."

"Making the atom serve man is a long and laborious task," Dr. Libby concluded. "Atomic scientists and technicians must first be trained and given experience. Experimentation and development work must be carried on continuously. The job is not a short one, but with large measures of patience, faith, and imagination, we confidently anticipate the time when all men will realize the full potential of the atom."

Technical Sections

United States papers were submitted to cover every agenda item of the entire Conference, and the United States presented orally at least one paper in every technical session. Generally, the United States Delegates offered the key papers, and led the discussion period, for which they prepared in meetings of delegates held prior to each technical session.

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[2] The regulation was published in the *Federal Register* on January 11, 1956.

Nearly all United States papers were presented by leading men in the fields covered. The authors supplied full and competent answers to questions asked about the papers, and asked well-formulated questions on the papers of others to stimulate discussion and to bring out additional information.

The papers presented by all participants in the Conference and summaries of the discussions which took place in the technical sections were reported on by United States Scientific Secretaries [3] appointed prior to the Conference to do this, as well as to assist preparations of delegates for discussions. These reports have been published as part of the report of the Official Representatives to the Secretary of State, and verbatim transcripts of the Conference, plus the texts of all papers submitted, are being printed by the United Nations Secretariat.

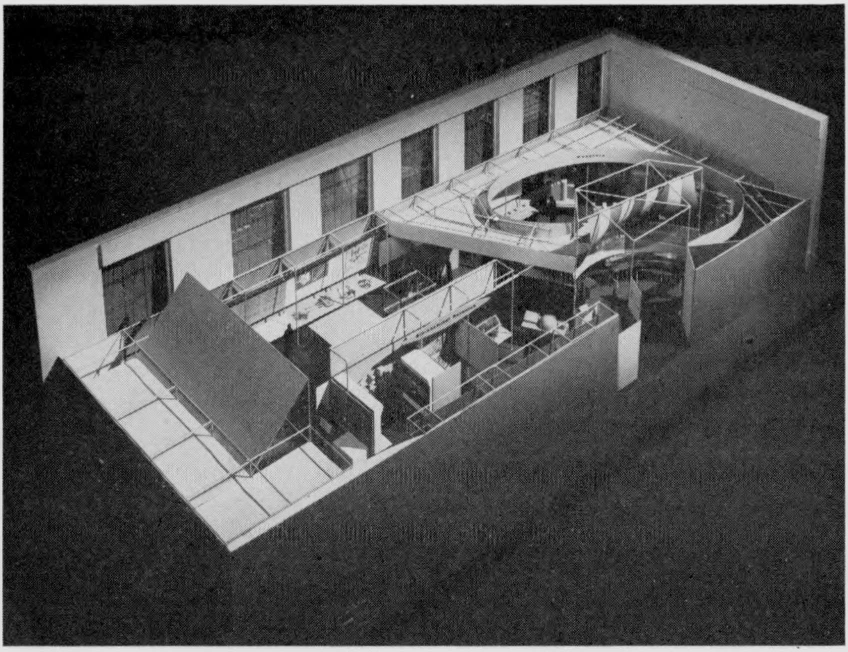
The United States presentation contained a considerable volume of material that previously had not been declassified. This release of information was accomplished without in any way infringing on sensitive areas of information, although there was no new pattern of declassification established exclusively for the Conference.

What did make this possible was the unprecedented number of papers submitted by United States scientists and engineers for the Conference agenda. All of them were screened according to the Declassification Guide, revised on the basis of recommendations first made by the Seventh Declassification Conference held at Harwell, England, in October of 1954. All recommendations for the revised Guide were reviewed and accepted by the responsible authorities of Canada, the United Kingdom, and the United States.

Evening Lectures

United States scientists delivered four of the ten evening lectures given during the Conference on subjects of broad scientific or public interest in connection with peaceful uses of atomic energy. On August 11, Dr. Ernest O. Lawrence, of the Radiation Laboratory, University of California, Berkeley, spoke on "High Current Accelerators." On August 15, Dr. Hans A. Bethe, of Cornell University, lectured on "Elementary Particles: Light Mesons," and in another concurrent lecture, Dr. Willard F. Libby, Atomic Energy Commissioner, discussed "Radiocarbon Dating." On August 17, Dr. Alexander Hollaender, of Oak Ridge National Laboratory, spoke on "Modification of Radiation Response."

[3] The United States scientific secretaries were Dr. Walter D. Claus, Dr. R. Carson Dalzell, Dr. Edward Epremian, Dr. L. E. Glendenin, Dr. George A. Kolstad, Dr. Karl M. Mayer, Dr. Robert D. Nininger, Dr. Paul B. Pearson, Dr. Alvin Radkowsky, and Dr. Ulysses M. Staebler.



A model of the U. S. Technical Exhibit in Room XV of the Library Wing of the Palais des Nations in Geneva.

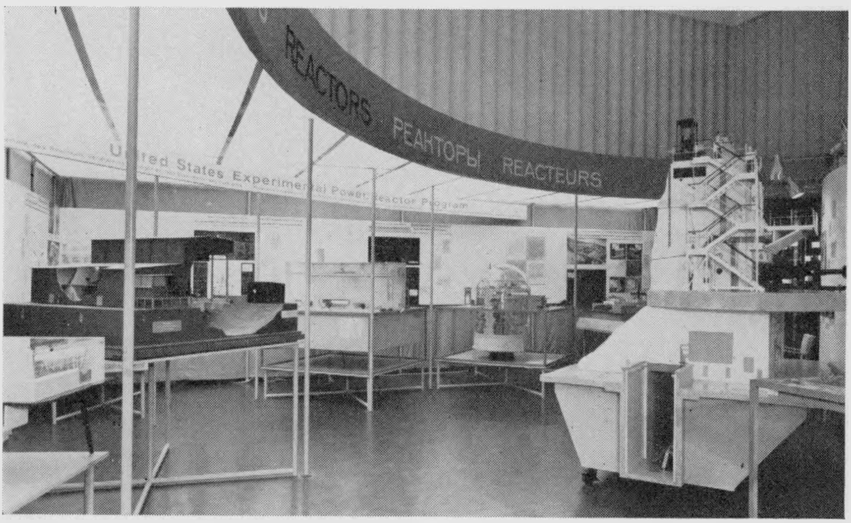
U. S. Conference Exhibits

The United States planned and executed comprehensive exhibits and a support program which supplemented the scientific and technical contributions made by this country to the Conference agenda.

The United States Technical Exhibit, in Room XV of the Library Wing, of the Palais des Nations, to which 105 academic, nonprofit, and commercial organizations contributed, drew about 36,200 visitors. The United States Research Reactor Exhibit, an operating pool-type research reactor, installed in a specially constructed building on the grounds of the Palais des Nations, was visited by 63,400 persons during the 2 weeks of the Conference. The United States Technical Library Exhibit, also in the Library Wing of the Palais des Nations, served as a reference library for delegates as well as demonstrating the type of technical library which the United States is presenting to other nations. It had about 19,500 visitors. An exhibit of a mobile laboratory and radiation detection instruments was set up in a truck semitrailer on the Palais grounds. This mobile radiological laboratory was visited by 25,000 persons. In addition, the United Nations showed daily in a small theatre in the Palais the eight motion pictures which the United States provided.

In the educational and commercial exhibit held at the Palais des Expositions in downtown Geneva under Swiss and United Nations auspices, the United States Government presented the United States Information Agency's educational display. This included an "Atoms-for-Peace" show which had been displayed in West Germany, and which contained exhibits from 18 United States organizations. Adjoining it were exhibits by 20 United States industrial and commercial organizations which had made independent arrangements with the Swiss sponsors.

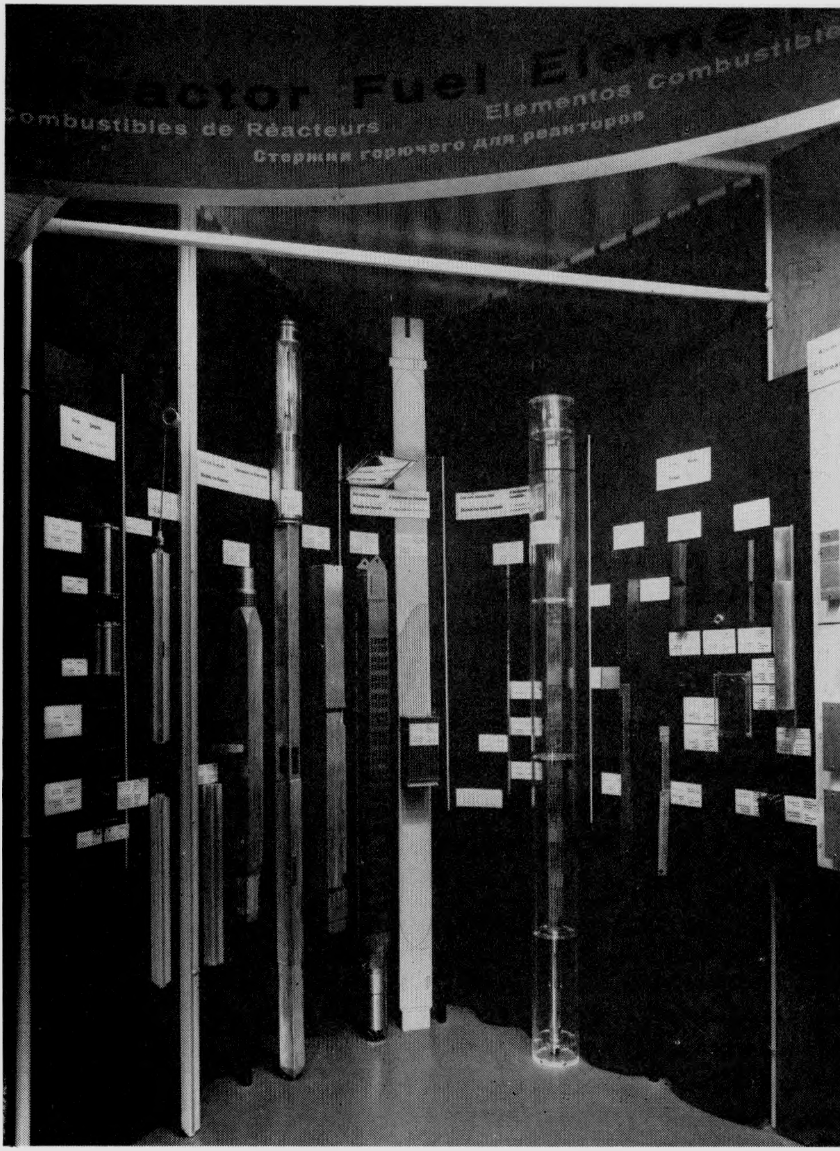
Altogether, in these exhibits, and including the 105 contributors to the Technical Exhibit at the Palais des Nations, 143 separate institutions and organizations participated. In addition, 50 associations and publishing houses contributed to the Technical Library Exhibit.



The reactor model section of the U. S. Technical Exhibit, with the four-language label above.

The *United States Technical Exhibit* filled a room 40 by 100 feet. The exhibits were laid out around the walls, and also around a central island. The Union of Soviet Socialist Republics exhibit was the only one in the Palais which occupied space equivalent to that of the United States. The USSR displayed models of three reactors, many mineralogical samples, and some experimental equipment. Intermittently, they showed a color film in English text on constructing and operating a power reactor.

The United Kingdom placed its main emphasis on the downtown commercial exposition. At the Palais des Nations, the United Kingdom emphasized power generation, showed a model of a Calder Hall



A portion of the reactor section of the U. S. Technical Exhibit which attracted a great deal of interest among technically advanced delegates: samples of reactor fuel elements, cross sections of fuel elements, and special metal shapes.

reactor, and gave information on seven reactors in all. Canada displayed a model of its NRX reactor, but placed main emphasis on a full-size teletherapy unit. The Danish-Norwegian-Swedish area featured a model of the Swedish Kjeller reactor, and Sweden, in addition, showed a mobile radiological survey unit. Belgium displayed a reactor simulator, some instruments, and its wall panels pictured research projects and the famous Congo Shinkolobwe mines. The French exhibit gave considerable emphasis to ore mining and processing, and included a simplified full-scale reactor control panel, operating in conjunction with a model of a vertical section of a reactor.

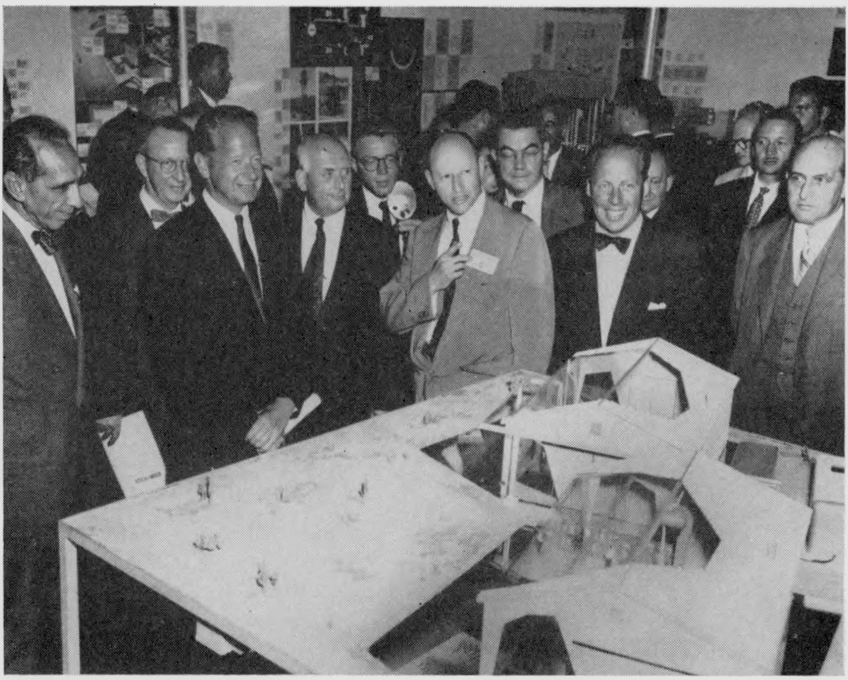
The United States exhibit included 10 reactor models, two of them small, and four drawings and diagrams for wall panels on additional reactors. There were samples of rare earths, with flow charts on their separation, actual samples of transuranic elements, a large continuously operating cloud chamber, a master-slave "hot" laboratory, a model of a chemical separating plant, a model of an Argonne National Laboratory greenhouse where plant experiments are carried out, growing samples of irradiation mutated plants from Brookhaven National Laboratory, a comprehensive display of radiation-detection instruments, including a hand-and-foot counter used to protect workers in atomic plants, a 100-channel analyzer—a so-called electronic "brain" used in scientific computations—from Los Alamos Scientic Laboratory, and a medical exhibit from the Sloan-Kettering Institute.

All of these bore explanatory labels, printed in the four official languages of the Conference. In addition, 25,000 copies of a four-language brochure describing the exhibit were distributed to visitors.

The United States Research Reactor Exhibit featured the operating "pool" reactor, installed in a specially designed and constructed building on the grounds of the Palais des Nations in Geneva. On August 22, the reactor was turned over to the representatives of Reactor, Ltd., on behalf of the Swiss Government, which purchased the reactor from the United States under a bilateral agreement of cooperation on peaceful uses of atomic energy signed July 18, 1955. Formal documents to transfer the reactor were signed on August 20, 1955.

The reactor was built by the Oak Ridge National Laboratory, operated for the U. S. Atomic Energy Commission by the Union Carbide and Carbon Corp. The idea was to demonstrate a type of research reactor which nations could expect to build under bilateral agreements of cooperation with the United States, using uranium enriched to 20 percent in the fissionable 235 isotope—the type of atomic fuel the United States had pledged to contribute to an international pool.

On June 30, the reactor was loaded at Knoxville, Tenn., aboard two Military Air Transport Service planes—a C–124 Globemaster and a C–54 cargo plane—and arrived in Geneva July 2. By July 18, just 14 working days after its arrival, the reactor and all its equipment were installed and, on that morning, the reactor "went critical" for the first time in Geneva. By July 15, the wall panels and other units of the exhibit also were in place.

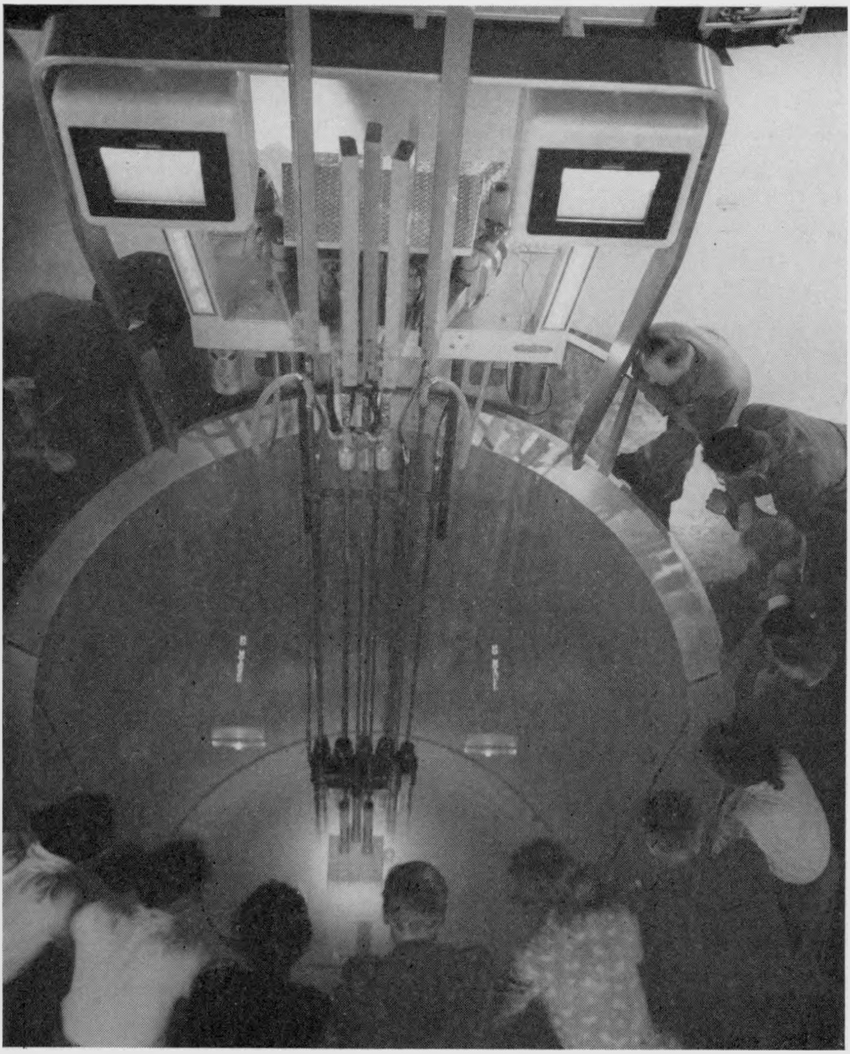


Dr. George L. Weil conducts a group of United Nations officials through the U. S. Technical Exhibit. Dr. Weil (pointing), second, on his right, Mr. Dag Hammarskjold, Secretary General of the United Nations, and on his left, Dr. Gunnar Randers, atomic energy adviser to Mr. Hammarskjold.

The reactor was placed in the center of the building, the core visible in a waterfilled cylindrical iron tank 10 feet in diameter and sunk 20 feet into the earth, imbedded in solid rock. The superstructure of the reactor supported two strip-chart recorders of reactor activity and the drive mechanism of the control rods. Underwater lights illuminated the pool when the reactor was not operating. They were turned off when, every 15 minutes during the exhibit hours, the reactor was brought to criticality and then up to its full power of 100 kilowatts to demonstrate the blue glow of the Cerenkov effect.

The active core was composed of 18 kilograms of uranium, enriched to 20 percent in uranium 235, and enclosed in aluminum "sandwiches." There were 23 fuel elements compactly arranged and mounted on an aluminum grid plate supported from the bottom of the tank. The 13,000 gallons of ordinary water which filled the tank, and was circulated through the demineralizer, served as coolant, moderator, and shield.

The panels displayed behind the glass front of the control room were more elaborate than required for the operation of the reactor, and in

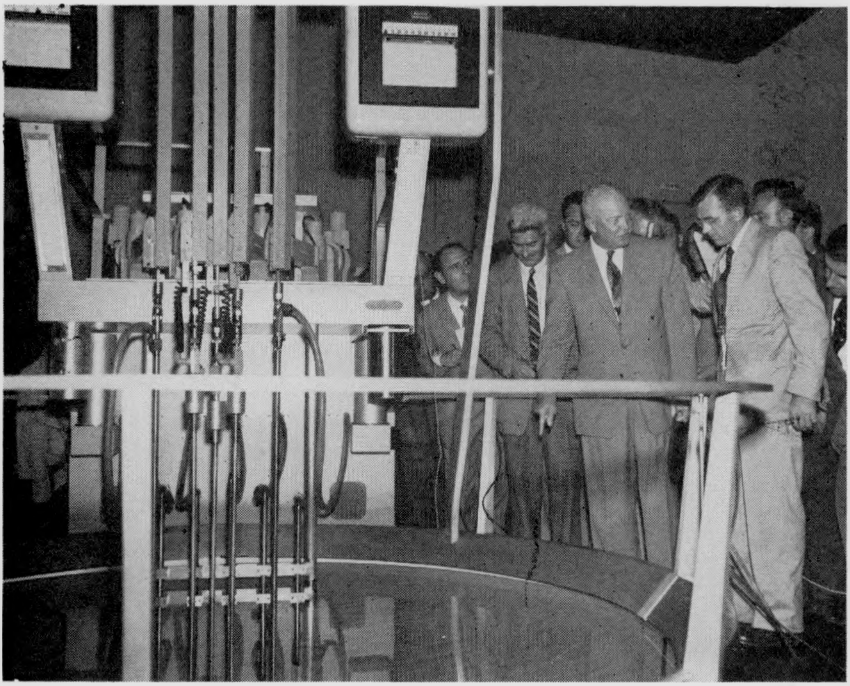


Visitors looking down into the U. S. research reactor exhibited at Geneva. The bright halo about the reactor core, seen at the bottom of the pool of water that serves as shield, moderator, and coolant, is the Cerenkov effect—a brilliant blue light caused by reactor radiation.

fact would have been adequate for a high power, short-period reactor. The pool reactor control mechanism included a completely automatic, one button, start-up, and a simple servomechanism to maintain constant power.

While the reactor was being installed, President Eisenhower was in Geneva for the "summit" Conference with the Prime Ministers of France, the Union of Soviet Socialist Republics, and the United Kingdom. On July 20, President Eisenhower visited the reactor exhibit, viewing the panels, and operating the reactor. He was accompanied by some 150 news representatives and photographers.

In a statement made there, President Eisenhower mentioned aspects of the Atoms-for-Peace program, and stressed his pleasure that "our country is able here to establish this reactor to help the scientists of the world to make progress along the lines of peaceful use of the atomic energy science, for the welfare of mankind. . . . I hope that private business and professional men throughout the world will take an interest, and provide an incentive, in finding new ways that this new science can be used."



President Eisenhower on his visit to the reactor during the "summit" conference in Geneva on July 20, 1955. He is standing beside the reactor pool.

The formal ceremonies turning over the reactor to representatives of the Swiss Government and of Reactor, Ltd. (a company financed 25 percent by Swiss AEC funds and 75 percent by Swiss private industry) took place at noon on Saturday, August 20.

Official participants in the ceremony were Dr. Paul Scherrer, acting for the Swiss Government, Dr. Walter Boveri for Reactor, Ltd., United States Ambassador to Switzerland Frances E. Willis, AEC Chairman Lewis L. Strauss and Commissioner Willard F. Libby.

The documents were signed, congratulations were exchanged and the reactor was formally transferred.

At noon Monday, August 22, 1955, the Swiss took physical possession of the reactor building. The tentative timetable called for erection of a building in Wurenlingen (near Zurich) by early spring of 1956 when the reactor, its equipment and exhibit panels would be moved.

Chairman Lewis L. Strauss makes a brief statement at the ceremonies turning over the research reactor to the Swiss Government purchasers. Seated beside the reactor are, left to right, U. S. Ambassador to Switzerland Frances Willis, Dr. Paul Scherrer, representing the Swiss Government, and Dr. Willard F. Libby.

The United States Technical Library Exhibit installed in the Palais des Nations in Geneva included a depository collection similar to those which the United States is presenting to cooperating nations as part of the "Atoms-for-Peace" program. The depository collection was presented to the United Nations after the Conference.

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The United States Technical Library Exhibit contained:

a. The AEC depository collection.
   (5,200 full-size copies of printed and photostated reports, 55,000 index cards)

b. Books on atomic energy furnished by publishers.
   (150 titles)

c. Journals containing articles on atomic energy.
   (62 titles)

d. Material describing the components of the United States Exhibition.
   (48 reports, 4 copies each)

e. Microcards of AEC reports.
   (approximately 7,000)

f. Two microcard readers.

g. Conference papers.
   (2 sets)

h. Complimentary commercial exhibit literature.
   (89 different items, approximately 17,000 copies)

This comprehensive collection provided information, that, coupled with information previously published in technical journals and books, represents the total contribution of the United States to the unclassified and declassified scientific literature on atomic energy. Guides to the literature, journals of abstracts, and librarians' manuals, were included to simplify reference. An assembled card catalog arranged by subject, author, and report number provided an index.

The Technical Library Exhibit also included over 150 books on atomic energy contributed by American publishers and a display of technical and business journals published in the United States.

Booklets, pamphlets and data sheets prepared by private companies which exhibited products, equipment, and processes in the United States Technical Exhibit in the nearby Room XV of the Palais des Nations and the United States Reactor Building on the Palais grounds, were available in the Technical Library. For the convenience of delegates and visitors, a card index of this material was also available.

Besides serving as a display, the exhibit provided a working reference library for delegates attending the Conference.

On August 20, Dr. Willard F. Libby, vice-chairman of the United States Delegation, presented to the United Nations Library in Geneva, this United States Technical Library. The gift of the Library was received for the United Nations by Dr. A. C. Breycha Vauthier, chief librarian.

Dr. Libby stated that the Library would be kept up-to-date by the U. S. Atomic Energy Commission which will provide, as they are issued, all new unclassified published documents originated in the

Commissioner Willard F. Libby shakes hands with Dr. A. C. Breycha Vauthier (right), United Nations Chief Librarian, after presenting to the United Nations on behalf of the United States, a technical library on peaceful uses of atomic energy. A portion of the U. S. Technical Library Exhibit at Geneva is in the background.

AEC program. Dr. Libby pointed out that the Library is a depository collection similar to those which the AEC maintains at 47 points in the United States and has presented to 35 other nations and international organizations as part of President Eisenhower's "Atoms-for-Peace" program.

Possession was turned over to the United Nations Chief Librarian by the United States staff on August 22.

A Mobile Radiological Unit, installed in a truck semi-trailer, was placed on the Palais grounds to the east of the northern Library Wing that housed the United States Technical Exhibit. The trailer was planned and constructed for the AEC for use in field tests of actual or potential radiation, and other toxic hazards.

The mobile laboratory, housed in a 35 x 8 foot trailer, contained radiation monitoring and analytical equipment for use near laboratories or industrial establishments where radioactive materials are used. It was designed so that specific instruments may be removed or installed to meet specific requirements.

It contained also fume hoods, especially designed to provide, in limited space, the same ventilation as full-scale equipment, air compressors, electrical generation equipment, and a liquefied petroleum gas system, in addition to supplies of deionized water, of reagents and other chemical equipment, standard radiometric equipment, benches for repairs of equipment. To facilitate decontamination, all exposed surfaces are of smooth-finish plastic or stainless steel, and with a minimum of crevices. Generating equipment, gas supply, and ail transformer networks are enclosed in a fireproof compartment forward.

Motion pictures. In addition to the eight technical films that the United States contributed to the United Nations *motion picture program*, the United States sponsored a single showing in English of a film, "Borax." The eight technical films supplied to the United Nations in the four official languages of the Conference were "Nuclear Reactors for Research," "Sodium-Graphite Reactor Progress Report," "Developing Homogeneous Reactors," "Construction of the Argonne Research Reactor," "Safety Experiments with a Boiling Reactor," "Radioisotopes: Their Application to Humans," "The Radioisotope in General Science," and "A Is for Atom."

Selected Reference Material

To supplement material presented in its technical and scientific papers, and to provide more detailed information on many aspects of the peaceful uses of atomic energy, the United States presented to the Official Representatives of the 73 nations and eight specialized United Nations agencies taking part in the Conference, and to Conference and United Nations officials, handsomely bound blue and gold 8-volume sets of Selected Reference Material.

The first presentation of the sets was made by Chairman Strauss at a luncheon for United Nations Conference Officials given August 9 by the United States Official Representatives. Each was presented with a copy of a special Introductory Volume. Chiefs of national delegations were notified in letters from the Chairman that a set was being reserved for each official representative and was available through the United States Technical Library at the Palais des Nations, and that additional sets could be shipped from the United States to whatever address each wished. Copies of the special Introductory Volume, printed in four languages, and illustrated with color photographs, were distributed in Geneva, as were 136 of the 8-volume sets.[4]

The Introductory Volume carried, as a dedication, the statement from President Eisenhower which was displayed on placards both at the United States Technical Exhibit and at the Research Reactor Exhibit. In a preface to the Volume, Chairman Strauss said:

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[4] Additional paper-bound copies of 7 volumes of the set are for sale by the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C.

"Interchange of scientific and technical knowledge will greatly facilitate the work of the scientists and engineers whose skills will be devoted to the future development of the peaceful uses of atomic energy.

"The United States has made available to the world's scientific community a large body of such data. In honor of this historic Conference and to stimulate further exploration and development of the beneficial applications of nuclear energy, the U. S. Atomic Energy Commission has prepared this special collection of technical data for the use of the delegates and the nations represented.

"The purpose of this collection is to provide information concerning the ways that we have found in which fissionable materials can be put to work in nuclear reactors for research purposes and for the production of power and radioisotopes.

"It is our sincere hope that this material will be of practical value to the men and women of science and engineering in whose hands the great power of the atom is becoming a benign force for world peace."

Educational and Commercial Exhibits

The educational and commercial exposition at the Palais des Expositions, included approximately 150 industrial exhibits from as many firms in eight countries, plus the educational shows of France, the United Kingdom, and the United States. It was estimated by sponsors that there were about 40,000 visitors, including delegates who attended without charge and public paid admissions.

The exposition literature listed France as having 49 exhibitors, the United Kingdom 37, Switzerland 23, the United States 20, West Germany 11, Belgium 5, and the Netherlands and Lichtenstein, one each. The United States Government did not officially sponsor commercial participation in the exposition, but notified individual concerns that might be interested so that they could, if they wished, arrange independently to have exhibits there.

France, the United Kingdom, and the United States sponsored educational displays, that of the United States being the previously mentioned United States Information Agency's "Atoms-for-Peace" show from West Germany.

Results of Conference

In the planning stages of the Conference, Dr. Rabi pledged to other nations that the United States would throw its "full weight" behind preparations for the Conference, and would gather the "best work of the best brains" for its participation. The report of the Official Representatives to the Secretary of State declares that the Representatives "believe that this promise was fulfilled in the United States presentations at the Conference, and that the United States contribution to world knowledge through the Conference was entirely representative of United States progress in developing, in all its many aspects, the peaceful uses of atomic energy."

Their report states that "it will not be possible for some time to appraise fully the results of the Conference. Certain results can be cited with confidence, and others can be inferred as probable."

The following accomplishments of the Conference are then cited:

1. The exchange of information, and the friendly intercourse among delegates to the Conference, began the re-establishment of world-wide communication among atomic scientists and engineers. The stimulation of these contacts, the access to new and broader information, provides an opportunity for the inventive imagination of the world of science to explore, to discover, and to develop new knowledge for the benefit of all nations.
2. Great quantities of scientific and technical information, some of which never before had been made generally available, were freely exchanged among the delegates of all nations. All nations learned new facts. Countries on the brink of wide atomic development will consequently be able to plan ahead with greater confidence. Nations still without atomic programs have acquired a workable basis for determining what they can best undertake and how to go about it.
3. Through the full reports on the Conference which were widely carried by the news services of the world, people everywhere have had the opportunity to learn of the many useful and constructive purposes to which atomic energy can be applied for their betterment and welfare. As a consequence of this and of further cooperation among nations, it is reasonable to hope that the blind dread which many may feel of atomic energy, if they know it only as a destructive force, may be abated. This is particularly true since the Conference emphasized the highly significant fact that the scientific and industrial development changes being brought about by atomic energy, which can profoundly alter the economics and patterns of life of people throughout the world, is being guided by considerations for the biological requirements of man, and directed toward advancing human welfare.
4. The volume and quality of work reported by the United States to harness atomic energy for the welfare and betterment of

man, and this nation's willingness to share its knowledge and to learn from others, has helped to convince delegates from other nations of the sincerity of United States efforts to "strip the atom of its military casing and to adapt it to the arts of peace." The reports these delegates make to their nations, and the news of the Conference which has preceded them, should convey a new understanding of the peaceful policies and intentions of the United States.

5. If we are correct in this estimate, it must follow as a result of the Conference that people in other nations will have a greater understanding of the United States desire and efforts to achieve a decent and enduring peace.

In closing the report, the Official Representatives concluded that the Conference had fully justified the money, the effort and time which the United States invested in it, as the President recognized in urging that this Conference should be followed by another to continue "this great beginning of international cooperation."

Part Two

Major Activities in Atomic Energy Programs, July–December 1955

MAJOR ACTIVITIES IN ATOMIC ENERGY PROGRAMS, JULY-DECEMBER 1955

Raw Materials

Free-world uranium production and receipts of uranium in concentrates from both domestic and foreign sources continued to show substantial increases. Further expansion in production will result from the operation of new ore processing facilities under construction in the Union of South Africa, Canada, and the United States.

Domestic Production

Domestic uranium ore and concentrate production continued to rise, maintaining the United States' status as one of the leading uranium producers. Production will increase further with the expansion of present mills, the completion of new facilities now under construction, and the construction of additional mills upon completion of contracts now under negotiation.

Ore Production

During the last 6 months of 1955, the number of producing mines increased to an estimated 925, as compared with approximately 850 as of June of this year. Although the rate of increase in number of producing mines slowed considerably, the production rate from existing mines continued its sharp increase.

Uranium producing areas were extended by the first commercial deposits of uranium in Oregon and Texas and new areas of potential production were developed in North and South Dakota and Alaska.

Ore Processing

Ore production is in excess of current processing capacity but additional mill facilities are being provided at a rapid rate. Except for the Commission's mill at Monticello, Utah, all expansions and new mills are privately financed. Stockpiles of ore in excess of normal plant requirements are found only at locations where new mills have just been completed or at locations where new mills are either planned or under construction.

Contracts were completed between the AEC and the Rare Metals Co. and the Trace Elements Corp. for the construction and operation respectively of mills at Tuba City, Ariz., and at Maybell, Colo., and construction of these mills was begun. Two other mills, at Edgemont, S. D., and Moab, Utah, are under construction, and nine mills are in operation. A contract was signed in November with Continental Uranium, Inc. for construction of a mill in the vicinity of La Sal, Utah.

On the average, processing plants on the Colorado Plateau were operating at slightly above their rated capacities, accounting for the record levels of production reached during this period.

New Ore-Buying Station

The Globe, Ariz., ore-buying station and sampling plant was officially opened on July 5, 1955.

Uranium From Phosphates

Small tonnages of uranium concentrates continued to be produced and shipped as a byproduct of the recovery of phosphate chemicals and fertilizers from Florida phosphate rock.

Foreign Activities

Belgian Congo

The Shinkolobwe mine in the Belgian Congo continues as a significant producer of uranium concentrates.

South Africa

Production from South Africa increased with the addition of two new processing plants, bringing to 13 the number of plants now in operation. The Combined Development Agency, a joint United Kingdom-United States-Canadian organization for procurement of uranium and thorium supplies, has approved construction of one additional mill, bringing to 16 the total number of plants authorized.

Canada

In August, the Canadian Government announced that March 31, 1956 would be the deadline for negotiating further contracts for uranium in high grade concentrates with private companies. To qualify for a contract, the contractors must present reasonable evidence that production will commence about April 1, 1957. Contracts will terminate March 31, 1962.

The Eldorado Mining and Refining Co., Ltd. has announced plans to expand the capacity of its present mill in the Beaverlodge area of northern Saskatchewan. Substantial ore reserves have been outlined as a result of the recently completed development program at the nearby Verna property, which includes ground under lease to Eldorado. The expanded mill will also derive some of its ore supply from several small privately operated mines.

The large mill of Gunnar Mines, Ltd. in the Lake Athabaska area in northern Saskatchewan started up in August and the first unit is now operating at rated capacity.

In the Blind River area of Ontario, first production of uranium concentrates began with start-up of the milling plant of Pronto Uranium Mines, Ltd. in late August. Construction of the two milling plants of Algom Uranium Mines is proceeding on schedule. Consolidated Denison Mines, Ltd. began construction of a milling plant of substantial capacity, with operation expected early in 1957.

In the Bancroft area of eastern Ontario, Bicroft Uranium Mines, Ltd. is constructing a mill which is scheduled to begin treating ore late in 1956.

The redesigned Port Hope refinery operated by Eldorado Mining and Refining Co., Ltd. is now producing metal grade (highly concentrated) uranium oxide.

Australia

Production of low-grade mechanical concentrates from the Radium Hill mine and treatment plant continued at a normal rate, with shipments being made to the Port Pirie chemical treatment plant, which began operation in mid-August. Shipments continued to be received from the Rum Jungle ore processing plant.

Portugal

Portuguese operations continued at a normal rate during this period.

Domestic Exploration

Increases in domestic ore reserves, both on and off the Colorado Plateau, again reflected the greatly expanded exploration activity of private industry. This has permitted orientation of Government exploration activities performed by the Commission and the U. S. Geological Survey to appraisal of results of private exploration and execution of basic geologic programs. Private interests have now assumed virtually all drilling activities in connection with uranium exploration and development.

Government drilling, restricted to support of geologic investigations, amounted to less than 200,000 feet in the last half of 1955 in comparison to 358,000 feet in the first half. The first commercial deposits of uranium were found in Oregon; significant reserves are being developed in the Dakota plains lignite fields; and a considerable tonnage of uranium ore has been found in Karnes County, Texas. Recent preliminary investigations indicate the possibility of an important uranium deposit on Prince of Wales Island, southeastern Alaska. A major discovery was made in the Ambrosia Lake area of McKinley County, N. Mex. during the period. Preliminary results of drilling by private companies indicate that reserves in the area may amount to several million tons.

Process Development

Work on the development of various uranium recovery processes continued at the U. S. Bureau of Mines Experimental Station at Salt Lake City, Utah, the National Lead Co., Inc. operating the Raw Materials Development Laboratory at Winchester, Mass., Battelle Memorial Institute, the Dow Chemical Co., and Arthur D. Little, Inc.

Laboratory and bench scale studies on Chattanooga uraniferous shale continued at Columbia University.

Production

The production of the various special nuclear materials during the last half of 1955 equalled or exceeded the quantities produced during the first half of the year.

Construction of the gaseous diffusion facilities at Portsmouth, Ohio, is ahead of schedule as the last building is nearing completion. Construction of additional feed processing facilities which began last March at Fernald, Ohio, St. Louis, Mo., and Paducah, Ky. is under way.

Privately Owned Feed Material Facilities

On October 27 the Commission announced it would accept proposals from industrial concerns for the manufacture of uranium feed material. Deadline for submission of proposals is October 1, 1956.

Specifically, the Commission is interested in receiving proposals from qualified firms to process, over a 5-year period, uranium ores or concentrates to either uranium trioxide, uranium tetrafluoride, or uranium hexafluoride, with deliveries to begin about April 1, 1959. The Commission will consider proposals for any production rate up to a maximum of 5,000 tons U_3O_8 equivalent per year. Proposals may be based on arrangements whereby the U_3O_8 concentrates are supplied by the Commission and refined salts returned.

Alternatively the Commission will consider proposals for direct purchase of the refined products from a company having or obtaining its own supply of uranium ores or concentrates. In the latter connection the Commission will consider appropriate modifications in contracts now in effect between the AEC and suppliers of uranium concentrates.

During November a "Formal Inquiry for Purchase of Uranium Products from Private Industry" was sent to about 600 companies. These companies and other interested persons were invited to a general orientation meeting designed to present the scope and magnitude of the undertaking. Proper security clearances were required for attendance at the sessions.

More than 100 persons representing 70 companies attended. The meeting was held in Washington on December 8.

Mississippi Valley Generating Co. Contract

By letter dated July 16, 1955, the Director of the Bureau of the Budget confirmed an oral notification of July 11 to the Commission that the President had accepted the commitment of the mayor of Memphis, Tenn., that the city would construct a powerplant adequate to serve the people of that community without requesting any funds from the Federal Government toward construction; that in this situation there was no longer any requirement for the arrangement made with the Mississippi Valley Generating Co.; and that the President was requesting the Commission to take immediately the necessary steps to bring to an end the relationship between MVGC and the United States.

On July 11, 1955, the Commission's General Counsel submitted to the Commission his opinion that the MVGC contract had become effective pursuant to legal authority and constituted at that date a valid obligation of the Government.

On July 14, 1955, the Commission requested the views of the Comptroller General on the course of action it might pursue to accomplish the direction of the President and on the availability of funds appropriated to the Commission for expenditures in connection with such action.

On July 29, 1955, the Assistant Comptroller General confirmed the views expressed by the Commission's General Counsel as to the validity and effectiveness of the contract and advised that, insofar as the contract terms and statutes applicable to the operations of the Atomic Energy Commission were concerned, the Government had no right at that time to terminate the contract without liability and that if the MVGC was willing to enter into an agreement of settlement, the Commission could use its appropriated funds for the payment of the settlement.

However, he called attention to the hearings of the Subcommittee on Antitrust and Monopoly Legislation of the Senate Committee on the Judiciary which were then in progress, and which raised questions of possible conflict of interest and public policy with respect to the contract. In the circumstances he suggested that the Commission consider appropriate means to protect the interest of the United States should it develop that the Government is entitled to relief from liability on the ground of public policy.

On July 30, 1955, the Commission notified MVGC of the President's direction that AEC take the necessary steps to bring to an end the relationship between MVGC and the United States. The hope was expressed that the parties might agree on a mutually acceptable basis for bringing the contract to an end.

On August 2, 1955, limited negotiations looking toward a possible settlement were begun. At the outset of these discussions, the company was put on notice that the Commission was studying the conflict of interest and public policy question, and there was a clear understanding that the Commission was not waiving any contentions which might be available to the United States on this score.

In the meantime, in a letter dated August 1, 1955, the Commission asked the Comptroller General's office for clarification of its suggestion regarding the taking of appropriate means to protect the interest of the United States on the public policy issue.

The Assistant Comptroller General replied, in a letter dated October 3, 1955, that the evidence so far presented before the Senate Judiciary Subcommittee (June 27–August 3, 1955) indicated the possibility of a violation of 18 USC 434 or other conflict of interest statutes in connection with the negotiation of the Dixon-Yates contract which might well affect the contract which resulted. It was his view, therefore, that no settlement of the liability of the United States in connection with the contract should be made which did not save to the Government the right to have the public policy issue judicially determined should it later be decided to follow that course of action.

On October 7, 1955, in a letter to the Joint Committee on Atomic Energy, the Commission advised that it had been studying the potential effects upon the contract of the questions of possible conflict of interest and public policy developed in the Senate Subcommittee hearings. It was stated that, on the basis of the study done thus far, there might be a question as to the validity of the contract and in the circumstances the Commission had decided to hold in abeyance the negotiation of the major aspects of a settlement with MVGC until the analysis had been completed. Representatives of MVGC were advised of this decision.

An opportunity was offered to the company representatives to provide their views in the matter, and a memorandum dated October 18, 1955, on phases of the evidence adduced in the Senate Subcommittee hearings and related evidence in the earlier SEC hearing (of June 1955) was submitted to the Commission by Daniel James, Counsel for MVGC.

On November 22, 1955, the Commission's General Counsel submitted to the Commission his opinion dated November 15, 1955, reviewing the hearings before the Senate Subcommittee and the SEC, and related data respecting the contract. In brief the evidence indicated that an officer and director of a firm which became the financial agent of the contractor, while acting in aid of the contractor with the knowledge of and at the request of its principal representative, also acted as one of the principal advisors to the Government in the negotion and formation of the terms of reference upon which the contract was founded. The opinion concluded that there was a substantial question as to whether there were material violations of law and public policy in the inception of the contract which violations would result in its being held invalid by the courts.

On November 23, 1955, the Commission advised MVGC that, upon the advice of counsel, the conclusion had been reached that the contract was not an obligation which can or will be recognized by the United States. Notice of this action was also given to the Joint Committee on Atomic Energy, the Budget Bureau, the Comptroller General and the Attorney General, together with copies of the General Counsel's opinion. At about the same time, the action of the Commission was made public along with the General Counsel's opinion.

On December 13, 1955, the MVGC filed suit in the United States Court of Claims for $3,534,778 claimed for breach of contract.

Military Application

Analyses of the results of Operation TEAPOT, the test series conducted at the Nevada Test Site in the spring of 1955, opened several new and promising avenues for weapons research and development. These should lead to weapon development which will strengthen materially the defenses of this nation and the free world. Research and

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development during the last half of calendar year 1955 proceeded on an expedited basis, both for these new approaches and for those established by earlier study and test.

Increases were made in the staffs of the Los Alamos Scientific Laboratory, Los Alamos, N. Mex., and of the University of California Radiation Laboratory, Livermore, Calif. Additions to certain of the engineering and production units of the weapons complex were put underway. Weapons production continued in accordance with the directive of the President.

Safety Tests

To further the knowledge concerning the safety of weapons in storage and transit, the Los Alamos Scientific Laboratory began a series of experiments on November 1, 1955 at the Nevada Test Site. These experiments were designed to provide essential data concerning the behavior of the various weapons and devices under conditions simulating those which might occur in case of fire or accident. These were small scale tests and therefore the personnel and material requirements were considerably less than those for previous tests.

Eniwetok Test Series Announced

On January 12, 1956, the Commission and the Department of Defense jointly issued the following announcement:

"In the absence of effective international agreement safeguarded by adequate inspection to limit or control armaments, the United States Government continually endeavors to maintain the most modern efficient military strength for purposes of peace. Pursuant to this course, preparations are under way for a series of nuclear tests to begin in the spring at the Eniwetok Proving Grounds. One of the important purposes of this series will be the further development of methods of defense against nuclear attack.

"Air and sea traffic will be notified through normal channels of the details of the control area well in advance of the commencement of operations.

"Operations will be conducted by Joint Task Force 7, commanded by Rear Adm. B. Hall Hanlon, USN. Dr. Alvin C. Graves, Los Alamos Scientific Laboratory, is Deputy Commander for Scientific Matters."

Chairman Lewis L. Strauss, of the Atomic Energy Commission, made the following supplementary statement in response to published speculation and inquiries of correspondents.

"The forthcoming series of nuclear tests at the Eniwetok Proving Grounds, as announced today by the Commission and the Department of Defense, will involve weapons generally smaller in yield than those tested during the 1954 test series.

"It is anticipated that the energy release of the largest test will be substantially below that of the maximum 1954 test."

Additions to the Complex

During the last half of calendar year 1955, several important additions to the weapons development and production complex were begun or completed. The Commission's Mound Laboratory at Miamisburg, Ohio, operated by the Monsanto Chemical Co., was assigned new production and development functions for the program. Effective July 1, 1955 its administration was transferred from Oak Ridge Operations Office to Santa Fe Operations Office.

The Rocky Flats Plant near Denver, Colo., operated by the Dow Chemical Co., is undergoing an important expansion. Architect-engineer work is being done by the Catalytic Construction Co. of Philadelphia, Pa., and the construction work is being accomplished by the Swinerton and Walberg Co. of San Francisco, Calif., and Denver, Colo.

A $2.5 million expansion project at the Commission's Albuquerque plant, operated by the American Car & Foundry Industries, Inc., was nearing completion. Other smaller additions were undertaken at other existing weapons facilities and at the national weapons laboratories.

Tenth Anniversary of the Alamogordo Test

The Los Alamos Scientific Laboratory held an open house on July 16–17, 1955 the tenth anniversary of the detonation of the world's first nuclear explosion at Alamogordo, N. Mex. Local residents and guests, including representatives of the press and the educational and scientific fields, thus had the opportunity to be informed of the unclassified facts on the nature of research facilities needed by such a laboratory and of the type of research accomplished, both for defense and for peaceful application.

Reactor Development

The program of developing reactors for industrial and military power and for naval and aircraft propulsion made significant progress during the last 6 months of 1955. Expenditures for this period totaled approximately $62.3 million.

In September the Commission issued its second invitation under the power demonstration reactor program for proposals to develop, design, construct and operate power reactors ranging from 5,000 to 40,000 kilowatts of electrical capacity to demonstrate the practical value of such units for commercial use.

Emphasis continued on development of advanced power reactor technology through a number of experimental reactor projects. In this program four reactors are under construction, three of which are scheduled to be completed in calendar year 1956, and the fourth in 1957. Construction of a fifth is scheduled to start in 1956. In addition four new small reactor experiments are underway to explore other promising reactor concepts.

In the field of military reactor development, the Large Ship Reactor project advanced to the architect-engineering stage and decision was made to build the prototype at the National Reactor Testing Station in Idaho. The USS *Nautilus*, powered by the Submarine Thermal Reactor, Mark II, had steamed more than 25,000 miles and the reactor continued to operate satisfactorily. Development work for a boiling reactor to produce about 200 kilowatts of electricity was begun as a part of the Army program. Prospects for nuclear powered flight continued to show promise.

A major tool for developing all kinds of reactors, the Engineering Test Reactor, advanced to the architect-engineering stage. In purpose, it is a companion to the Materials Testing Reactor and is to be built next to the MTR at the National Reactor Testing Station.

Following a survey which defined the shortage of nuclear engineers, the Commission announced its first summer short course in reactor technology for college faculty members. Waiver of certain charges for fuel for reactors for educational institutions was also announced.

Civilian Power Reactor Program

Pressurized Water Reactor

During the last 6 months of 1955 substantial progress was made in the construction of the Nation's first large-scale (60,000 kilowatt) civilian nuclear powerplant—the Pressurized Water Reactor (PWR) at Shippingport, Pa. Westinghouse Electric Corp. is developing, designing and fabricating the nuclear portion of the PWR for the AEC. The Duquesne Light Co. of Pittsburgh is building the conventional portion of the plant and will operate the entire plant when it is complete.

Excavation was completed in July. First concrete for the reactor foundation was poured in August and some 15,000 cubic yards of concrete were in place by November 1. Erection of the steel structures to house the nuclear portion was begun in November by the Pittsburgh-Des Moines Steel Co. under a fixed price subcontract to Westinghouse.

The reactor vessel, which will contain the core of uranium fuel, is now being constructed by Combustion Engineering Co. in its Chattanooga, Tenn., shops. The plate in this vessel, 8½ inches thick including a ¼-inch cladding of stainless steel, was rolled by the Lukens Steel Co. of Coatesville, Pa. Special transportation arrangements will be required to move this 33-foot long, 12-foot diameter vessel to the site at Shippingport.

Two steam generators are being constructed by The Babcock & Wilcox Co. and two by Foster Wheeler Corp. All other major components are on order with first deliveries expected early in 1956.

The Duquesne Light Co. has placed purchase orders for all major equipment to be installed in the turbine-generator portion of the plant with delivery expected concurrently with nuclear components. In addition, the company will assume up to $5 million of the cost connected with development and construction of the reactor portion of the plant and will purchase, at specified rates, steam generated by the reactor.

Industrially sponsored large pressurized water atomic powerplants, somewhat modified by comparison with the Shippingport plant, have been proposed by Yankee Atomic Electric Co. (see p. 47–48), and earlier by the Consolidated Edison Co.

Boiling Water Reactors

The Argonne National Laboratory continued its work on the development of boiling water reactors. This type of reactor differs from the pressurized water reactor in that steam generation is allowed to take place in the reactor pressure vessel at the core itself.

The development of the technology of the boiling reactor involved a series of reactor tests known as the Borax experiments, the first of which (Borax I) was operated at the National Reactor Testing Station in Idaho in 1953. The second experiment (Borax II) was conducted during the winter of 1954–55 to study the steady state and transient characteristics of a boiling reactor and to define the limits of stable operation as a function of variables such as pressure and specific power.

The Borax III experiment used the same reactor vessel as Borax II, but incorporated a new core to produce greater thermal power. In addition, a 3,500-kilowatt turbine-generator was installed. This reactor became critical on June 9, 1955, and on July 17, 1955, the town of

Arco, Idaho, was connected by transmission line to the Borax powerplant. For an hour and five minutes electricity exclusively from this plant was furnished to Arco.

The next step in the development of the boiling reactor project is the construction and operation of the Experimental Boiling Water Reactor powerplant (EBWR), which is designed to produce 20 megawatts (20,000 kilowatts) of heat and 5,000 kilowatts of electricity. A plant of this capacity was considered to be the minimum which would enable sound extrapolation to large size central station powerplants. The EBWR is now under construction at the Argonne National Laboratory and is expected to be generating power during the latter part of 1956.

Sargent & Lundy Co. of Chicago is the architect-engineer for the project; the Sumner Sollitt Co. has a lump-sum contract for construction of the reactor building; the turbine-generator, condenser, circulating water pumps, and associated equipment are being fabricated by the Allis-Chalmers Co. The reactor vessel is being constructed by The Babcock and Wilcox Co., and the Graver Tank Co. has erected the steel containment shell.

The boiling reactor for which Commonwealth Edison and associates have requested a license would carry this type of atomic powerplant to the full-scale stage.

Sodium Reactor Experiment

A sodium-cooled, graphite-moderated experimental reactor of 20 megawatts heat capacity is being built by Atomics International, a division of North American Aviation, Inc., at Santa Susana, Calif., 25 miles northeast of Los Angeles. The engineering test building, to be used for conducting experimental tests and for assembling fuel elements, moderator, and other reactor components, was erected by the Dudley Steel Co. and is now occupied by Atomics International personnel. The reactor building is scheduled for completion in January 1956 by the George A. Fuller Co.

Many of the large components of the reactor assembly are ready for installation. The core cavity liner and the outer tank, fabricated by the American Pipe and Steel Corp. were completed and assembled. The inner core tank was completed for assembly in November by the Southwest Welding and Manufacturing Co. The sodium pumps, being manufactured by the Byron Jackson Co., and the sodium heat exchangers, fabricated by the Alco Products, Inc., are being assembled for installation.

Final assembly of all components for the SRE is scheduled for April 1956. Full power operation is anticipated by July or August

1956. Meanwhile, engineers are being trained for reactor operation, and experimental testing of reactor components is being continued.

Original plans did not provide for generating steam or electricity with the SRE. However, all public and private utilities within transmission distance were queried. A contract is being negotiated with the Southern California Edison Co., under which they would, without cost to the Government, install and operate a turbine-generator plant including heat exchangers and other electrical equipment. The company would pay the Commission 45 cents per million BTU for the heat used to generate electricity, and has agreed to share with public power groups the information developed in the installation and operation of the generating equipment.

The Commission has accepted for negotiation a Power Demonstration Reactor Program proposal from the Consumers Public Power District of Columbus, Nebr., for the construction and operation of a large sodium-graphite power reactor. The fabrication of this reactor is expressly contingent upon the successful operation of the Sodium Reactor Experiment.

Atomics International completed a preliminary design study for a 75,000-kilowatt net electrical plant which takes full advantage of the experimental and fabrication experience gained with the SRE. This study is the basis on which Consumers submitted its proposal.

Fast Breeder Reactors

Numerous experimental tests were conducted at the first Experimental Breeder Reactor (EBR–1) to evaluate this system further. Fuel elements of plutonium were fabricated for EBR–1 and will be in use in the near future. The plutonium loading will give valuable technical information on breeding and control behavior, and will provide other nuclear engineering data.

The development of the second Experimental Breeder Reactor (EBR–2) is well underway. The plant will be sodium-cooled, and will generate 62.5 megawatts of heat, and produce 15,000 kilowatts or more of electricity.

A one-half scale, non-nuclear mechanical model of the EBR–2 was built at the Argonne National Laboratory. The model operated successfully and demonstrated the technical feasibility of operating mechanisms under sodium at temperatures of 700° F. The hydraulic characteristics of the sodium-coolant system and the performance and reliability of the electromagnetic coolant pumps are being determined.

Construction of the EBR–2 is scheduled to start in 1956 at the National Reactor Testing Station. The reactor is due to be in operation at full power in calendar year 1959.

The construction of a zero power fast critical assembly was completed at the Idaho testing station. This facility began operation in October and will be used to provide accurate data necessary for the detailed design of the core of EBR–2.

A facility for the development and experimental fabrication of fuel elements containing plutonium is an essential requirement for the development of fast breeder reactor powerplants. Construction of such a facility at Argonne National Laboratory is underway with completion scheduled for 1956.

The sodium-cooled fast breeder type of atomic powerplant would be carried to the large-scale stage by the Power Demonstration Reactor Program proposal of the group headed by the Detroit Edison Co. for a 100,000 kilowatt installation, (see p. 47).

A fast breeder reactor concept of advanced design is being investigated by the Los Alamos Scientific Laboratory. The reactor would use molten plutonium as fuel and sodium as coolant. Potential advantages include elimination of fuel element fabrication, greater burn-up, improved heat transfer characteristics and high breeding ratio.

Homogeneous Reactors

A homogeneous reactor is one in which the fuel material is evenly mixed throughout the moderator. Aqueous homogeneous reactors are attractive for the production of power because the fluid state of the fuel and the unique quality of heavy water as a moderator make possible such desirable characteristics as high power density and low fuel inventory, continuous removal of fission products and radiation damage products, high degree of nuclear stability, elimination of fuel element fabrication, elimination of control rods, and simple mechanical design.

Aqueous homogeneous reactors are classified as *one-region*—if the fissionable and fertile materials are uniformly mixed—or *two-region*—if the fissionable material is in a core, surrounded by a blanket of fertile material in a shell. They are also classified as *circulating fuel* or *boiling*, depending upon the method of removing heat.

Primary responsibility for the aqueous homogeneous reactor program is assigned to the Oak Ridge National Laboratory where the Homogeneous Reactor Experiment No. 1 (HRE–1) was designed and constructed, and in 1954 dismantled after 2 years of successful operation. The program is now focused on the Homogeneous Reactor Experiment No. 2 (HRE–2), a two-region system.

The objectives of the HRE–2 are: to demonstrate that a homogeneous reactor of moderate size can be operated with the continuity required of a powerplant; to establish the reliability of engineering materials and components of a size which can be adapted to full-scale powerplants; to evaluate equipment modifications leading to simplifications and economy; to test simplified maintenance procedures, particularly maintenance under water; and to develop and test methods for the continuous removal of fission and corrosion contaminants.

Construction of the HRE–2 is scheduled for completion early in 1956. Following the usual mechanical and leak testing, the reactor will be put into operation with only heavy water in the blanket system. The fuel will be in a dilute solution of uranyl sulfate (about 90 percent uranium 235) in heavy water. Operation is expected to continue with this combination for a minimum of 6 months to establish the reliability of operation and to test the effectiveness of continuous chemical extraction processes. For the latter purpose, a chemical pilot-plant is attached directly to the reactor.

During this period the power output of the reactor probably will not exceed 10 megawatts of heat. Later, modification for operation at higher power is contemplated. In further testing it is planned to use a blanket consisting of a suspension of thorium oxide in heavy water.

The HRE–2 core tank which is also a pressure vessel and a blast shield, has been fabricated and tested by Newport News Shipbuilding and Dry Dock Co., and shipped to Oak Ridge. The low-pressure fuel-system assembly and low-pressure blanket-system assembly were mounted and operated on test stands to check their performance. The reactor cell structure was finished and tested satisfactorily at design pressure. All component fabrication is now complete.

The Pennsylvania Power & Light Co. and the Westinghouse Electric Corp. notified the Commission that they are working on the development of a full-scale homogeneous atomic powerplant which will utilize technology to be developed in the Oak Ridge program.

In addition to the program at the Oak Ridge National Laboratory, work on the development of aqueous homogeneous reactors using uranyl phosphate solution and a different mechanical arrangement was undertaken at the Los Alamos Scientific Laboratory. The present effort is directed toward two concepts: the first, the Los Alamos Power Reactor Experiment (LAPRE) No. 1, will employ a circulating pump; the second, the LAPRE No. 2, will depend on natural convection to circulate the fuel. No. 1 will generate fairly high pressure steam and have a thermal output of 2 megawatts. No. 2 will produce a lower pressure steam and have a thermal output of about 1.3 megawatts; no electricity will be generated. Both of these Power Reactor Experiments are expected to be critical in early 1956. The reactors involved are of the "test tube" type, so-called because of the tall cylindrical pressure vessel which contains not only the fuel solution but also the heat exchanger or boiler for the generation of steam. Thus, circulation of the highly radioactive fuel solution outside the pressure vessel is avoided.

Other Reactor Concepts

Organic-Moderated Reactor Experiment. The Commission began negotiations with Atomics International, NAA, Inc., of Downey, Calif., to undertake jointly the sponsorship of an Organic-Moderated Reactor Experiment (OMRE) to be conducted at the National Reactor Testing Station. The estimated cost of the initial phase of the project is $1.8 million.

The experiment, using the hydrocarbon diphenyl as moderator-coolant, will carry forward research done for the Commission by North American Aviation. The use of organic compounds as reactor moderators and coolants has several potential advantages—low induced radioactivity, low corrosion of fuel elements, and high boiling point which makes high temperature systems possible. The present experiment (to generate 5 to 15 megawatts of heat) is designed to simulate conditions of heat transfer, temperature, and coolant flow contemplated for a practical power reactor.

The North American proposal was selected as the best of five submitted to the Commission as a result of AEC's expressed interest in this technology.

Liquid Metal-Fuel Reactor. A reactor using a molten metal as a carrier for uranium is believed capable of operating at high temperatures and relatively low pressures. The temperatures may be high enough so that the steam conditions are comparable to those in modern conventional generating plants. For several years the Brookhaven National Laboratory has conducted fundamental research on the application of this concept to practical reactor systems.

A technical team under The Babcock and Wilcox Co. completed a study of the Brookhaven National Laboratory data and calculations as applied to a reactor concept using graphite as moderator and a uranium solution in liquid bismuth as fuel. The study concluded that "the wide flexibility in design and the economic potentialities of the Liquid Metal-Fueled Reactor (LMFR) concept justify efforts to conduct aggressively the necessary research and development required to bring a full-scale plant into existence."

The construction and test operation of a small reactor experiment to explore this concept is being considered.

Other promising types of power reactors are being investigated, including the gas-cooled type.

Industrial Participation

Power Demonstration Reactor Program

In September the Commission issued its second invitation to private industry under the Power Demonstration Reactor Program for proposals to develop, design, construct, and operate power reactors in a range of capacities to demonstrate the practical value of such units for commercial use. The invitation called for proposals especially directed to nuclear powerplants in the following ranges: 5,000 to 10,000, 10,000 to 20,000, and 20,000 to 40,000 kilowatts of electricity. Closing date for receipt of proposals is February 1, 1956.

The invitation was extended to individual organizations or to groups of organizations representing private or publicly-owned utilities, equipment manufacturers, or others.

The Commission will evaluate the proposals on a competitive basis within the limits of funds and materials available. The Commission may accept one or several proposals, or it may find that none is acceptable. In addition to the types of assistance which the Commission indicated that it would consider offering in connection with the January 1955 invitation, it would also consider in this second program financing and retaining title to all or part of the reactor system.

Under the Commission's original request for proposals last January (pp. 41–43 Eighteenth Semiannual Report, January–June 1955), four proposals for reactor plants with a combined electrical capacity of 455,000 kilowatts were received.

During July the Commission authorized the General Manager to proceed with contract negotiations with two of the proposing organizations—the Detroit Edison Co. and associates, which proposed a fast breeder reactor plant with 100,000 kilowatts capacity to be completed in late 1959, and the Commonwealth Edison Co. and associates which proposed a boiling water reactor plant of 180,000 kilowatts capacity to be completed in 1960. The Commonwealth Edison proposal was later considered solely an application for a license since no Government assistance was sought.

The Commission also determined that the proposals submitted by the Consumers Public Power District of Columbus, Nebr., and the Yankee Atomic Electric Co. did not constitute acceptable bases for contract negotiations under the criteria established for the power demonstration reactor program. Accordingly, in response to Commission invitation both proposals were revised and resubmitted for Commission consideration.

On October 27 the Commission announced that the revised proposal of the Consumers District could be accepted as a basis for contract negotiations. The Consumers proposal is for a sodium-graphite reactor plant of 75,000 kilowatts capacity to be completed in 1959.

A revised Yankee Atomic Electric Co. proposal for a pressurized water reactor powerplant is undergoing AEC review. In addition to modifying the proposal to change those elements considered unacceptable by the Commission, the company altered the technical design features, including an increase in planned electrical output from 100,000 to 134,000 kilowatts. The company estimates its plant would begin to operate in 1960.

Naval Reactors Program

The objective of the naval reactors program is the development of a group of naval nuclear powerplants in a wide range of power ratings. This group consists of a series of reactors ranging from 3,000 to 40,000 shaft horsepower which can be used singly or in multiple to power new naval ships from small submarines to the largest aircraft carriers.

The first naval reactors program consisted of two projects—the Submarine Thermal Reactor and the Submarine Intermediate Reactor. Two more projects for submarine application, the Submarine Advanced Reactor (SAR) and the Submarine Reactor Small (SRS), and a project for surface ship application, the Large Ship Reactor (LSR), have been added.

Submarine Reactors

Work was begun on modifications to the prototype Submarine Thermal Reactor (STR) Mark I at the National Reactor Testing Station in Idaho to change it to a test facility for investigating new developments in technology, design, and operation of improved water-cooled nuclear powerplants. This work is being performed by the Westinghouse Electric Corp. and the Electric Boat Division of General Dynamics Corp. While this work is being performed, the prototype plant is being refueled after 2½ years of operation.

The USS *Nautilus*, powered by the Submarine Thermal Reactor, Mark II, has steamed in excess of 25,000 miles, during a large portion of which it was totally submerged. The *Nautilus* also cruised, submerged, from New London, Conn., to San Juan, Puerto Rico, a distance of more than 1,300 miles, in 84 hours at an average speed of about 16 knots. The reactor continued to operate satisfactorily.

The Submarine Intermediate Reactor (SIR) Mark A, the land-based prototype nuclear powerplant for the submarine *Seawolf*, is being test-operated for the AEC at West Milton, N. Y., by the General

Electric Co. The SIR Mark B which will power the submarine is under construction by the same company at the AEC's Knolls Atomic Power Laboratory, Schenectady, N. Y. The submarine which was launched in July is being fitted out at the Electric Boat Division of the General Dynamics Co., Groton, Conn.

General Electric is also continuing to generate electricity from surplus steam from Mark A with the turbine generator installed and operated by the company at no cost to the Government. However, since no power in excess of the Commission's needs is being generated at West Milton, the contract with the Niagara-Mohawk Power Co. for sale of the resultant electrical output which expired on October 11 has not been renewed.

Public bodies and cooperatives entitled to preference in disposition of the power under section 44 of the Atomic Energy Act of 1954 have indicated an interest in the power but have not been able to make arrangements for its transmission. In an effort to afford every possible opportunity to these groups to obtain the advantages of the preference provisions of the Act, they were given until February 1, 1956, to submit firm proposals for the purchase of West Milton power at the bus bar at the established price of 3 mills per kilowatt-hour. May 1, 1956, was established as the date by which the customer must obtain the means of taking and delivering the power sold.

Work on the Submarine Advanced Reactor (SAR) continued at the Knolls Atomic Power Laboratory. Earth was moved at West Milton, N. Y., in preparation of the site for construction of test facilities for the prototype of this nuclear propulsion plant. This prototype will be constructed in the area adjacent to the Submarine Intermediate Reactor, Mark A.

On July 15 the AEC contracted with Combustion Engineering, Inc., for design and development work on the Submarine Reactor Small project.

Large Ship Reactor

Design and development work on the Large Ship Reactor (LSR) continued at the Bettis Plant at Pittsburgh, Pa., by the Westinghouse Electric Corp. under AEC contract. Construction of the prototype for this project will commence in the spring at the National Reactor Testing Station in Idaho. A contract for the architect-engineering work for the prototype was awarded to Arthur G. McKee and Co. of Cleveland, Ohio. The Newport News Shipbuilding and Dry Dock Co. was awarded a contract to perform the design of the special shipboard features of the prototype plant.

Army Reactors Program

The objective of the army reactors program is the development of land-based package reactor systems suitable for meeting heat and power requirements of the military services in remote areas.

The program now includes two major development projects—the Army Package Power Reactor (APPR-1) and the Argonne Low Power Reactor (ALPR).

Army Package Power Reactor (APPR-1)

Construction of the plant, which will employ a pressurized water reactor and be capable of producing 1,825 kilowatts of electricity, was begun at Fort Belvoir, Va., on October 5. Alco Products, Inc., is the prime contractor. Completion date of the guaranteed performance lump-sum contract was advanced by 5 months to July 10, 1957, by contract amendment.

Development work supporting military pressurized water reactor systems continued. This work included heat transfer tests at Columbia University, critical experiments at the Oak Ridge National Laboratory (ORNL), and fuel element irradiation tests at ORNL and the National Reactor Testing Station.

Argonne Low Power Reactor (ALPR)

In November a project was established leading to a boiling heterogeneous reactor powerplant for military use, having an output of about one-tenth that of the APPR-1. A 1-year development and engineering design program was initiated at the Argonne National Laboratory to permit early construction. Selection of a contractor is in progress.

Advanced Reactor Systems

Preliminary design studies on advanced reactor systems for eventual application to military and civilian use were completed, and materials development work was initiated. Preliminary design of a proposed reactor experiment to furnish experimental data for incorporation into reactor engineering designs was begun.

Conceptual design studies of very small reactor systems to meet additional requirements continued with the completion of a study by the Glenn L. Martin Co., Baltimore, Md. Sanderson and Porter, Engineers, New York City, under contract to the Engineer Research and Development Laboratories, Fort Belvoir, Va., completed preliminary design of a small, gas-turbine powerplant suitable for use with a nuclear reactor.

Aircraft Reactors Program

The aircraft nuclear propulsion program was accelerated, and the prospects for nuclear-powered flight continued to show promise. Construction of initial test facilities at the aircraft nuclear test area at the National Reactor Testing Station was completed and some test work commenced. The Aircraft Nuclear Propulsion Department of the General Electric Co. is the operating contractor.

In the early fall, design and construction work began on a new Air Force plant and laboratory at Middletown, Conn., which will enable Pratt & Whitney Aircraft Division to enter more extensively into the aircraft nuclear propulsion program. The facility will be used for both AEC and Air Force work.

General Engineering and Development

Sanitary Engineering

Major emphasis continued to be placed on the solution of problems arising from the handling and disposing of high level radioactive wastes. Chemical plants which process irradiated fuel elements are the chief source of these wastes.

At the Brookhaven National Laboratory, the pilot plant for the fixation of radioactivity on montmorillonite clay continued "hot" operation to provide data for possible application to full-scale plants. Application of this technique to various types of wastes from fuel processing is being studied. At the Johns Hopkins University, investigations were started on the fixation of fission product wastes on hydrated aluminosilicates.

The Oak Ridge National Laboratory worked on the fixing of radioactivity in mixtures of natural earth materials such as limestone, shale, and sodium carbonate. The use of radioactive decay heat in accomplishing this fixation is also under investigation. Fixation studies were also carried out at the Los Alamos Scientific Laboratory, Argonne National Laboratory, and at the chemical processing plant at the National Reactor Testing Station.

The possibilities of ocean disposal were considered by a meeting of advisory oceanographic experts at the Woods Hole Oceanographic Institute. This conference resulted in the conclusion that a number of oceanographic questions must be answered before the feasibility of such disposal can be assessed.

A conference of geologists, petroleum engineers, and other geophysical experts at Princeton University considered for the Commission the possibilities of underground disposal. They concluded that such direct disposal may be technically feasible in deep basin formations containing stagnant brines, in spaces formed by dissolution in salt beds or salt domes, in excavations in impermeable shales and, under certain conditions, in unsaturated zones at considerable distances above the water table. However, much development work is required before this kind of disposal can be put on a practical, continuously operating basis.

Disposing of wastes by pumping them into wells drilled for the purpose was investigated at the University of California. Major effort on this project was directed to study of the reaction between radioactive materials and standard earth materials.

Oak Ridge National Laboratory continued its investigation of the use of surface pits excavated in the Conesauga shale formation for direct disposal of high level radioactive wastes to the earth.

Evaluation of the dilution factors in streams with respect to low level wastes was continued by Harvard University and the Technological Institute of Northwestern University. At Massachusetts Institute of Technology, fall-out data collected during the 1955 weapons test at the Nevada Test Site in 25 water supply systems throughout the country were compiled and interpretation was begun. It was apparent that nowhere did radioactivity concentrations reach levels which would create a public health problem.

At the U. S. Bureau of Mines, design work progressed on incinerators for disposing 30 and 100 pounds per hour of combustible wastes contaminated with low-level radioactivity. The design was started by the Harvard Air Cleaning Laboratory.

Two major conferences attended primarily by AEC and contractor personnel were held—the Fourth Annual AEC Air Cleaning Conference at Argonne National Laboratory and the Third Sanitary Engineering Conference at the Robert A. Taft Sanitary Engineering Center of the U. S. Public Health Service, Cincinnati. The latter meeting, sponsored jointly with the U. S. Public Health Service, also was attended by state public health representatives.

Reactor Safety

Construction of the first Special Power Excursion Reactor Test facility (SPERT-1) and remote control center were completed at the National Reactor Testing Station. This unit is an unpressurized, light water-moderated heterogeneous reactor with aluminum clad, fully enriched uranium fuel plates. The reactor, operated for the Commission by the Phillips Petroleum Co., is similar to the Borax I deliberately destroyed in a transient test in 1954. The fuel elements, however, are more rugged in design to better withstand violent pressure surges.

Construction continued at Santa Susana, Calif., on a parallel facility for transient testing of small homogeneous reactors. This facility, called the Kinetic Experiment on Water Boilers (KEWB), will be operated for the AEC by North American Aviation, Inc.

Engineering Test Reactor

In August the Commission decided to undertake with Government funds the construction and operation of an Engineering Test Reactor (ETR) at the National Reactor Testing Station where facilities already exist for auxiliary services. Two private industry proposals to build this type of reactor were unacceptable to the Government for a number of reasons.

For example, both proposals required indemnification by the AEC for personal injuries and property damage arising from atomic hazards which could not be covered by insurance, whereas the Atomic Energy Act would require the owner of the reactor to hold the Government harmless from any damages resulting from the use of special nuclear materials.

In addition, both asked that the AEC guarantee payment of percentages of operating costs (including amortization) and profit to a degree approaching commitments which the Commission would have to make under cost-type contracts for construction and operation of an ETR as a Government facility. Furthermore, the estimated costs to the Government over the periods for which guarantees were requested were substantially in excess of the estimated cost of constructing and operating the ETR next to the Materials Testing Reactor at the National Reactor Testing Station.

An engineering test reactor is urgently needed to provide irradiation facilities for the development of reactor components for military and civilian power reactors. Existing facilities are not suitable for experimental work requiring relatively large spaces in areas with high neutron intensities.

Conceptual design of the ETR was prepared by the Atomic Energy Division, Phillips Petroleum Co. Architect-engineering and construction are being done by the Kaiser Engineers Division of the Henry J. Kaiser Co. Nuclear design of the reactor core and facilities within the tank is being performed by the Atomic Power Equipment

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Department of the General Electric Co. under contract to Kaiser. Overall cost of the reactor is estimated at $15 million. It is scheduled for completion early in 1957.

The core of the ETR will contain a number of experimental holes capable of accepting reactor fuel elements and other components. These holes will range up to 9 inches square and extend completely through the core and reflector. Nearly all will be provided with facilities outside the reactor tank, such as pumps, heat exchangers, sampling equipment and clean-up systems. These will form loops in which tests may be conducted at temperatures, pressures, and other operating conditions similar to those which the materials undergoing testing might experience in actual reactor applications.

The reactor—to operate at a power level of 175 megawatts of heat—will be light-water-moderated and -cooled, and will be fueled by uranium enriched in the isotope 235.

Materials Testing Reactor

Power level of the Materials Testing Reactor was raised from 30 megawatts of heat to 40 megawatts September 26, with a corresponding increase in the usable thermal neutron flux from approximately 3.5×10^{14} to 4.5×10^{14} neutrons per square centimeter per second, and the reactor has been routinely operated at that level since that time. The increase enables the reactor to handle a greater experimental load by making more high flux space available and, in some cases, shortening irradiation time.

The reactor has been operating at capacity, particularly with respect to the experimental holes providing the highest flux. The MTR is used both by AEC laboratories and private experimenters, with greatest emphasis being placed on experiments furthering the reactor development program. However, its high flux enables it to produce radioactive isotopes of greater intensity than is possible elsewhere.

A contract has been entered into between the Phillips Petroleum Co. which operates the Materials Testing Reactor under contract to the AEC, and The Babcock and Wilcox Co., New York City, for the commercial fabrication of reactor fuel elements on a fixed-price basis. The 325 fuel assemblies covered by the contract price of $90,766 are to be fabricated at a new Babcock and Wilcox plant at Lynchburg, Va. First deliveries are to be made in July 1956.

Ultimately, the contract will free Oak Ridge National Laboratory, which has been providing the fuel assemblies, of a routine manufacturing load, and at the same time will contribute to the development, within private industry, of skills related to the atomic energy program. The MTR is located at the AEC's National Reactor Testing Station in Idaho.

Radiation Studies

During August the Argonne National Laboratory placed into operation a large irradiation facility for studies of the effects of gamma radiation on foods and other materials. The facility utilizes spent MTR fuel elements as an intense source of gamma radiation. Twelve elements, each of which provides more than 100,000 curies of radiation, are used. These elements are replaced at frequent intervals in order to maintain a minimum radiation intensity of one million roentgens per hour. Sixty number-two cans of material can be irradiated at one time.

The facility is available to non-AEC organizations as a part of the Commission's program of providing assistance to industrial concerns, educational institutions, and Government agencies, for the development of peacetime uses of atomic energy. One of the principal users is the Army Quartermaster Corps which has recently begun a broad study of the sterilization of food by irradiation.

EDUCATION AND TRAINING ASSISTANCE

For some time the Atomic Energy Commission has been concerned with the shortage of engineers, in particular of nuclear engineers, and with the adverse effect the accumulating shortage will have on the development of a large nuclear power industry in the United States.

A survey of training and manpower requirements in the atomic energy industry for the next 3 years was completed during the period of this report. Data were collected from 201 industrial concerns having an established or potential interest in atomic power applications and from AEC Operations Offices and prime contractors. This survey showed that in the next 3 years in the United States alone there will be an annual demand for approximately 2,000 engineers and scientists—mostly engineers—in the atomic power field. Of these 2,000, it is expected that approximately 1,200 will already be trained in nuclear technology.

There are in the United States approximately 5,000 engineers and scientists effectively trained to work in this new industry. Present nuclear educational and training programs of all types are geared to turn out fewer than 500 engineers and scientists annually. As a consequence, on the basis of the short range requirements alone, there is an immediate need to expand education and training capacity.

Recognizing this need, the Commission recently adopted policies aimed at helping expand the capacity of universities and colleges for producing nuclear engineers in particular and thus partially to alleviate the shortage. In the longer range of 10 to 20 years, additional education facilities in this field undoubtedly will be required.

Research Reactor Assistance

The Commission continued its policy of assisting nonprofit and educational institutions in the construction and operation of research reactors. This assistance consists of waiving use charges on special nuclear materials and heavy water. In addition, no charge is to be made for special nuclear materials consumed in the operation of research and training reactors. The Commission will also provide funds or services without charge for the fabrication of fuel elements, preparation of fuel solutions and replacement and reprocessing of used fuel elements and neutron sources.

The fuel elements of the pool-type research reactor at the Pennsylvania State University were furnished under this policy. This reactor is now operating at a power level of 100 kilowatts and is scheduled to be raised to 1,000 kilowatts in the near future.

The "water boiler" homogeneous reactor at North Carolina State College was out of commission for some time for replacement of the main reactor core vessel, made necessary by corrosion caused by the uranium fuel solution. Repairs have been completed and the reactor is operating again.

The University of Michigan is building a pool-type research reactor. Massachusetts Institute of Technology, Cambridge, Mass., has completed the design of a heavy water research reactor.

A proposal has been received from Washington State University requesting the AEC to supply fuel elements for a swimming pool research reactor. In addition to the assistance available under the new policy, the University also seeks financial assistance in construction. The request is being considered.

Subcritical Facility Assistance

Although reactors are important training tools, subcritical reactors, or assemblies, are excellent for many nuclear physics and engineering laboratory experiments. The AEC adopted a policy of assistance to nonprofit educational institutions planning to acquire such facilities for training purposes.

The assistance available consists of loaning the source material, special nuclear material, or other needed special materials without charge. Such loans are subject to availability of materials. New York University was the first recipient of such a loan and the subcritical assembly constructed with the materials loaned was exhibited at the Nuclear Energy Congress in Cleveland, Ohio, during December. Massachusetts Institute of Technology has also asked for material for such an assembly and requests from other educational institutions are expected.

Summer Institute for Teachers

To assist universities in building qualified staffs to teach nuclear engineering, the Commission has arranged for the School of Nuclear Science and Engineering at Argonne National Laboratory to hold a special short course for college faculty members in the summer of 1956. This course will be under the joint sponsorship of the AEC, the National Science Foundation, the American Society for Engineering Education, and Northwestern University. Beginning the latter part of June and lasting 2 months, it will include nuclear physics, nuclear engineering, separation chemistry, metallury, and other subjects. Sixty faculty members from a number of colleges and universities can be accommodated.

Other Types of Assistance Planned

Funding for several other types of assistance is sought in the President's budget for 1957, now before the Congress. The aim is to increase the numbers of men and women trained for the work of the growing atomic energy program and nuclear power industry.

Oak Ridge School of Reactor Technology

In August, 84 students were graduated from the 1954–55 session of the Commission's Oak Ridge School of Reactor Technology, a 1-year graduate-level course run at the Oak Ridge National Laboratory. Of the 51 sponsored students, 33 returned to the AEC or to military contractors, and 18 to the military services and other Government agencies. Of the 33 unsponsored students, 30 accepted employment with the AEC or with military contractors, and the other 3 accepted employment with Government agencies. With the completion of the 1954–55 session, the school had graduated 374 men. The 1955–56 session commenced in September with 95 students.

Argonne School of Nuclear Science and Engineering

Twenty-two United States students—18 sponsored by industry, 3 from the AEC and 1 from the Rural Electrification Administration—were among the 62 students enrolled in the second 7-month unclassified course in the School of Nuclear Science and Engineering at the Argonne National Laboratory. This training facility was designed originally to fulfill the Government commitments under the International Atoms-for-Peace program (see International Affairs).

Physical Research

During the past 6 months, the Commission's physical research program continued to make significant contributions to fundamental knowledge of atomic energy and the related sciences. As a result of these recent accomplishments the horizons for future research have been widened. The research is carried on at the AEC's laboratories and through an off-site program that utilizes the scientific manpower and capabilities of universities and private laboratory contractors. At all of these sites, important on-the-job training of scientists and technicians is being combined with the Commission's research work. Below are reported findings in the physical research program illustrative of developments during this report period.

PHYSICS

High Energy Physics

Significant progress was made in the use and development of accelerators for research in high energy physics.

At Brookhaven, research with the cosmotron increased steadily in scope and the machine is now operating on 3 shifts, 5 days per week. A great deal of the research is done by physicists from collaborating universities. A large part of their effort is now devoted to the study of unstable particles, including heavy mesons and hyperons.[1]

Design and construction of the alternating gradient synchrotron at Brookhaven is progressing satisfactorily. The diameter of the magnet ring has been set at 842 feet. This dimension will provide an energy of at least 25 billion electron volts. It is estimated that the maximum attainable energy may reach 33 Bev, if the magnetic properties of the magnet steel can be quality-controlled in large scale production.

[1] See page 35, Sixteenth Semiannual Report to Congress (January-July 1954).

The most important advance in this program is the successful operation of the electron analogue. This is an experimental alternating-gradient machine which accelerates electrons rather than protons. Built to study orbit dynamics, it is 45 feet in diameter, has an aperture of 0.8 inch square, and has very strong focusing. Operation of the analogue has already provided much experience in the handling of alternating gradient machines and has confirmed the calculation of the characteristics of orbits for the larger machine.

At the University of California Radiation Laboratory in Berkeley, the performance of the bevatron was improved significantly as a result of modifications to all of the accelerator components. Additions and improvements were also made to the target area, the beam steering and tracing facilities, and the automatic programming equipment.

Antiproton Discovered

The most important result of research performed with the bevatron during this report period was the discovery of the antiproton. Identification of the particle was achieved by a team of UCRL physicists composed of Drs. Owen Chamberlain, Emilio Segre, Clyde Wiegand, and Thomas Ypsilantis. The help of Herbert Steiner and the cooperation of Dr. Edward Lofgren, physicists in charge of the bevatron, were instrumental in the discovery.

Detection of the antiproton fulfills one of the important purposes for which the multi-billion volt bevatron was constructed. The existence of antiprotons has been a basic tenet of generally accepted nuclear theory for a quarter of a century. Despite continuing experiments with cosmic rays, however, the particle had not been detected. The long lapse between the prediction of the antiproton and its discovery had brought into question the validity of the most basic concepts of nuclear properties. This elimination of uncertainty about one of the cornerstones of nuclear theory is the discovery's most important feature.

The antiproton does not exist in the atomic nucleus, which is composed of only protons and neutrons. Rather, it is born in some high energy nuclear event, such as a collision resulting from bombardment of targets by protons accelerated in the bevatron. Until the bevatron was constructed, nuclear bombardments of sufficient energy to create antiprotons could not be achieved.

To produce the new particle, protons are accelerated in the bevatron to 6.2 billion electron volts. These particles are directed at a target of copper inside the bevatron chamber. When a proton of this energy strikes a neutron or proton of one of the copper atoms, the following come out of the collision: the two original particles (the proton projectile and the struck neutron or proton); and a pair of newly created particles, a proton and an antiproton. In the collision a part of the bombarding proton's energy is converted into the mass of the new proton and antiproton, according to Einstein's theory.

The antiproton is stable in a vacuum and does not disintegrate spontaneously. However, when it comes into contact with a proton or a neutron, the two particles immediately annihilate each other, their mass being transformed into energy which will usually be carried by 2 or more mesons and gamma rays.

The antiprotons were detected by devising a selecting apparatus—an experimental maze through which only particles with antiproton properties could pass. The distinctive properties to be demonstrated were a negative charge, a mass equal to that of the proton, and a long life in vacuum. All of the observations so far were made by means of radiation counters.

Though the discovery is important for understanding the processes by which atomic energy is released, no practical applications of the antiproton are now foreseen.

86-Inch Cyclotron •

The 86-inch cyclotron at the Oak Ridge National Laboratory has been used in demonstrating that many interesting radioisotopes can be produced economically and in large quantities. The unusually large currents of high-energy protons generated in this cyclotron make it a versatile tool for use in basic nuclear research; they also make it an unusually effective machine for the production of certain radioisotopes which are themselves useful tools in medical and biological research.

The cyclotron, completed in 1951, routinely produces currents 5 to 10 times larger than those available from other cyclotrons, and in many cases the protons are more effective for isotope production than the deuterons commonly available in other cyclotrons. Hence, the isotope production rates are higher and the isotope costs lower.

Production of radioisotopes in the Oak Ridge National Laboratory cyclotron complements, rather than competes with, radioisotope production in nuclear reactors. Whereas reactors produce isotopes containing a surplus of neutrons, the cyclotron is especially useful in producing the neutron-deficient isotopes. Since the latter are produced by transmutation from another chemical element, they can usually be chemically separated from the original target material so that the product is of high purity and very high specific activity.

High production rates of a number of radioisotopes have been obtained with the 86-inch cyclotron, including the following: beryllium 7, fluorine 18, manganese 54, cobalt 57, zirconium 65, cadmium 109, arsenic 74, and gallium 67.

The commercial processing and distribution of cyclotron-produced radioisotopes by the Oak Ridge National Laboratory have been discontinued. The isotopes produced in the cyclotron in the future will be processed and distributed through industrial laboratories. The 86-inch cyclotron will continue to be available, however, to any qualified group for service bombardments (without processing) where the machine offers unique advantages and can be used without interference with the research program.

Neutron Physics

For a number of years, the Neutron Cross Section Compilation Group at Brookhaven has collected and evaluated the numerous cross sections that are important to nuclear theory and reactor development. The results of this work have appeared in the cross section compilation AECU–2040, published in 1952, together with various supplements. A new edition of the compilation, containing many newly-declassified results regarding fissionable isotopes was prepared this year and distributed at the Geneva Conference on the Peaceful Uses of Atomic Energy. This new edition, BNL–325, also contains data on resonance parameters and inelastic scattering, which did not appear in AECU–2040. (For sale by Office of Technical Services, Department of Commerce, Washington 25, D. C.)

Because of the cooperation of other countries, it was possible to prepare in advance an addendum to BNL–325, containing cross sections to be presented at the International Conference on the Peaceful Uses of Atomic Energy, so that the addendum was available for distribution at Geneva. At the Geneva Conference, scientists from a number of countries, including the Union of Soviet Socialist Republics, combined their results to obtain a set of world's average cross sections of the fissionable isotopes uranium 233, uranium 235, and plutonium 239. The establishment of these cross sections is an example of the cooperation exhibited at Geneva, and will be of value in unifying reactor calculations throughout the world.

Spins and Magnetic Moments of Radioactive Materials

The technique of studying magnetic deflection of fine beams of atoms has been so perfected that it has become possible to determine the magnetic properties of the nucleus even for radioactive atoms. Among the determinable properties of nuclei are the strengths of their spins and their strengths as magnets. These can be determined in a so-called "atomic beam" apparatus by observing the deflections in magnetic and radio fields of a beam of atoms emerging from a hot furnace. Such results for radioactive nuclei are of special interest because the spin is one of the quantities determining the probability of radioactive disintegration.

An apparatus has been built by Argonne National Laboratory which has so far obtained data on 39 different materials at each of 20 values of the energy below 1.7 million electron volts, scattering at five different angles being measured simultaneously. The data are being computed by the AVIDAC for analysis.

Angular Distribution of Scattered Neutrons of Medium Energy

Neutrons, upon striking other nuclei, scatter in various directions. By determining the numbers scattered to different angles away from the original direction, scientists can obtain some insight into the mechanics of the collision process. The distribution is of importance in fast reactors, because if the scattering is predominantly forward, the neutrons are held back less effectively by such collisions than they would be if they were uniformly scattered in all directions.

An apparatus has been built by Argonne National Laboratory to collect a large amount of such information, using neutrons at many energies up to an energy of 1.7 million electron volts and with a large variety of scattering materials.

Electromagnetic Isotope Separation

Techniques and equipment necessary for the production of extremely high-purity samples of certain isotopes have been developed, and gram quantities of chromium 52, iron 56, lithium 6, and lithium 7, containing only one part isotopic contaminant in 100,000 parts of the desired isotope, have been produced in the ORNL electromagnetic separators.

Project Sherwood—Controlled Thermonuclear Research

During the Geneva Conference, Chairman Strauss announced that the United States has underway a long-range research program to develop the controlled release of energy from atomic fusion. It was emphasized at Geneva and in all subsequent discussions that the program—called Project Sherwood—is considered a very long-range effort.

The major research effort in this field is being carried out at AEC laboratories operated by the University of California at Los Alamos, N. Mex., and Livermore, Calif.; and at Princeton University. In addition, there are smaller projects at Oak Ridge, Tenn., and New York University. The programs at Los Alamos and Princeton began in 1951 as experiments to test ideas for the containment and control of thermonuclear combustion at temperatures comparable to those of the sun. Previously such temperatures have been achieved on earth only in atomic explosions. Shortly thereafter, a third program was initiated at Livermore, Calif., by the University of California Radiation Laboratory.

The possibility of tapping this source of energy has long been intriging to scientists. Some of the problems to be overcome, however, are extremely difficult. One problem is that of heating an appropriate nuclear material (such as deuterium) to temperatures of several hundred million degrees and of confining it at that temperature for a sufficiently long period of time to allow an appreciable portion of the nuclei to fuse together, with the consequent release of energy in the form of energetic neutrons, charged particles and gamma radiation. Once this temperature has been achieved the main problem would be that of getting enough thermonuclear energy back from the material to repay the power used to achieve and maintain the high temperature.

Although the level of research has been greatly expanded since 1951, the program is still in the research stage. Many years of intensive theoretical and experimental effort will be required before the first prototype of an operating thermonuclear machine is developed.

Chemistry

Rare-Earth Chemistry

Application of a liquid-liquid (tributyl phosphate-nitric acid) extraction process developed at the Oak Ridge National Laboratory for the separation of rare earths has greatly facilitated the production of 500 grams of the extremely rare element, europium. This is the largest known single quantity of this element, which is of interest because of its possible utilization in reactor control rods.

The Ames Laboratory isolated in its rare earth pilot plant more than 150 pounds of pure yttrium oxide which is being converted to the metal. This metal is presently of considerable interest in reactor development as are other rare earth metals and compounds.

Several industrial companies have shown interest in the production of rare earths on a pilot plant scale and are planning to use essentially the Ames Laboratory design and procedures.

Research at Ames on the separation of rare earths by ion exchange has been extended to new complexing agents which appear to be able to separate yttrium from other rare earths more readily.

Synthesis of Coffinite

Coffinite, since its discovery in 1951, has become recognized as a major uranium mineral of the Colorado Plateau. Its composition is believed to be USiO4, though the inability to obtain pure samples has prevented confirmation of the formula. Argonne National Laboratory scientists have now succeeded in synthesizing coffinite by a hydrothermal method, and its properties are under investigation. It is hoped that a study of the conditions required for the formation of coffinite in the laboratory will provide an explanation for its occurrence in nature and thus assist in the search for the mineral.

Elements 99 and 100

Through the cooperative work of the nuclear chemists of the University of California Radiation Laboratory, the Argonne National Laboratory, and the Los Alamos Scientific Laboratory, two new elements were identified in the debris of the "Mike" thermonuclear explosion which occurred in the Pacific Proving Grounds in November 1952. These new elements have the atomic numbers 99 and 100. Following their discovery the elements were produced and identified by laboratory methods.[2] Earlier this year, element 101 was identified at the University of California Radiation Laboratory, Berkeley (see p. 51, Seventeenth Semiannual Report to Congress, January-June, 1955).

It has been suggested that element 99 be given the name Einsteinium (Symbol E) and element 100, the name Fermium (Symbol Fm) in honor of the important contributions of Albert Einstein and Enrico Fermi to nuclear science.

Inhibition of Corrosion of Steel in Water by Pertechnetate Ion

A number of agents for lessening the corrosion of steel have long been known, a typical one being the chromate ion. Oak Ridge National Laboratory tested the corrosion-inhibiting characteristics of an ion of a technetium compound—the pertechnetate ion—with the resulting discovery that it is by far the most effective ion of this type. About 30 parts per million in water suffice to protect ordinary carbon steel completely from corrosion by water.

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[2] See page 41, Sixteenth Semiannual Report to Congress (January-June 1954) for description of laboratory method of production.

Since technetium does not occur in nature, but is produced in nuclear reactors, its high cost will probably preclude extensive practical applications. Nevertheless, continuing research with pertechnetate as an inhibitor is advancing knowledge of the phenomena of inhibition and of the corrosion process itself.

Slurries in Liquid Metals as Possible Reactor Fuels

A program has been initiated at Argonne National Laboratory to investigate suspensions of uranium compounds in liquid metals with the goal of developing a suitable uranium or plutonium slurry for use as a power reactor fuel. It has now been found that uranium dioxide which has been treated with hydrogen at 500° C can be readily suspended in liquid sodium-potassium alloy at room temperature and that it does not cake after prolonged settling. From the results obtained in a circulating loop, it may be concluded that a slurry containing 10 percent of uranium dioxide by volume can be easily maintained at uniform concentration. The slurry promises to be a useful reactor fuel.

Detecting the Free Neutrino

The neutrino is a hypothetical particle predicted to balance the energy and momentum in certain nuclear reactions. It has never yet been directly observed. Research at Brookhaven envisages the possibility of detecting the free neutrino by radiochemical methods.

The idea is to expose the chlorine nuclei in a large mass of carbon tetrachloride (about 1,000 gals.) to an intense flux of neutrinos from a nuclear reactor and to detect radioactive argon 37 produced by the capture of neutrinos in chlorine 37 nuclei. The technique has been refined to the point where neutrinos of the theoretically predicted properties could be detected—if they exist—and an experiment is being set up at one of the Savannah River reactors. A different experiment by Los Alamos scientists is aimed at detecting the neutrino by physical methods.[3]

Isotopic Labelling by Nuclear Recoil

Brookhaven National Laboratory has been conducting research on the chemical reactions of the "hot atoms" which recoil after a nuclear transformation. An outgrowth of this work has been the finding that these reactions can be used for labelling organic compounds with

[3] See page 31, Fifteenth Semiannual Report to Congress (July–December 1953) and page 36, Sixteenth Semiannual Report to Congress (January–June 1954) for explanation of "free neutrino" and the Los Alamos Experiment.

carbon 14 and with tritium. The yields are high enough to be useful in many cases. When nitrogen-containing organic compounds are exposed to neutrons, the carbon 14 atoms produced take the place of carbon or nitrogen atoms in the molecules with which they collide.

Similarly, tritium labelling is accomplished by exposing a mixture of salt of lithium (from which the tritium is produced) and an organic compound. This technique has been used to label sugars, aromatic acids, and steroids with tritium.

Chemical Isotope Separation

New methods for producing highly concentrated nitrogen 15 have been developed at the Ames Laboratory and at Columbia University. Gram quantities of nearly 100 percent purity material have been produced in the Ames Laboratory by ion exchange. A small-scale pilot plant has been set up and highly enriched material has been produced at Columbia by the nitric oxide-nitric acid exchange method. This material may be useful in homogeneous breeder-type reactors if it can be produced at sufficiently low cost.

METALLURGY

Dimensional Instability of Uranium

Two of the most important metallurgical problems associated with the use of uranium in nuclear reactors are corrosion and the dimensional instability of uranium. Since uranium is highly corrosible and the radioactive fission products must be prevented from entering the reactor system, the uranium fuel is usually clad in a protective jacket. The effectiveness of this jacket, however, can be greatly impaired by dimensional changes in the uranium fuel during use. These changes also reduce the flow in the cooling system of heterogeneous reactors, in which coolants pass through narrow channels past the fuel elements.

For these reasons considerable research has been conducted on the dimensional instability of uranium in order to understand the basis of the phenomenon and seek means of minimizing or eliminating it.

Dimensional changes in uranium can occur as a result of thermal cycling (repeated heating and cooling) or irradiation with neutrons. The mechanisms of these two effects differ, but both are based on the fact that uranium is anisotropic. This means that at temperatures below 660° C the crystal structure of uranium has different physical properties in the three principal crystallographic directions.

Thermal Cycling Effects

As an indication of thermal cycling effects, a polycrystalline rod sample of wrought uranium can extend to about 6 times its original length when subjected to prolonged cycling between temperatures of 50° and 600° C. This increase in length is accompanied by a decrease in diameter and essentially no change in volume.

Such effects occur particularly in wrought material because the fabrication process produces a preferred orientation, that is, the working of the metal tends to place the individual grains of the material in the same direction in the length of the rod. It has been found that the greater the degree of preferred orientation, the greater the uni-directional growth upon thermal cycling.

A less drastic effect of thermal cycling, found particularly with cast uranium, is a roughening of the surface. It is now known, however, that if uranium is prepared, processed, or heat treated in such a way as to produce a very fine grain structure with completely random orientation, neither axial growth nor surface roughening will occur upon thermal cycling. It has been found that the addition of small amounts of certain alloys of about one percent by weight can produce an indirect effect on the thermal cycling behavior of uranium by influencing its grain size.

A single-grain sample of uranium does not undergo dimensional changes upon thermal cycling. Several mechanisms have been proposed to explain thermal cycling effects based on the interactions of grains in the polycrystalline metal and the anisotropy of uranium. Although a great deal of progress has been made in understanding the effects of thermal cycling, a completely satisfactory theory for the phenomenon has not yet been developed and work on this continues.

Irradiation Effects

When a single crystal of uranium is irradiated by neutrons, it progressively elongates in one (010) crystallographic direction, shrinks in a second (100) direction and remains unchanged in the third (001) direction. At 100° C, this dimensional instability involves an extension of about 50 percent after sufficient irradiation to cause fission of 0.1 percent of the uranium atoms. The volume changes accompanying this phenomenon are negligible.

When polycrystalline rod samples with a high degree of preferred orientation are irradiated, it has been found that the rate of growth may be as much as twice that of a single crystal. It is also known that in such rods, other things being equal, the rate of linear growth upon irradiation becomes greater with increasing cold work and also with decreasing grain size.

Irradiation also can produce a roughening of the surface. Caused by the individual grains growing in different directions, this is most noticed in coarse grained samples. A third type of dimensional change is due to an increase in volume.

This effect is much smaller in magnitude than irradiation or thermal cycling extension. It consists of an increase in volume on the order of 1 percent after 0.1 percent of the uranium atoms have fissioned, as compared to a possible 100 percent increase in length of a highly oriented polycrystalline sample for the same irridation. This change is thought to be due to internal porosity in addition to the extra volume of fission product atoms, as the latter does not quantitatively account for the effect.

As a result of these studies, several means of decreasing or eliminating the dimensional changes of uranium under irradiation have been developed. Fabrication techniques and heat treatments are used to control the grain size and obtain a random orientation of the grains. Dimensional stability can also be greatly enhanced by suitable alloying. Additions of chromium, molybdenum, niobium, and zirconium alone and in combinations can refine and randomize the grain structure through heat treatment with resultant improvement of stability. By using still greater amounts of these alloying elements, a crystal modification can be obtained at room temperature which has excellent dimensional stability under irradiation.

Of the several mechanisms which have been advanced to explain the growth of uranium under irradiation, a very promising explanation is based on the anisotropic diffusion of displaced atoms and vacancies produced in the lattice by irradiation and fission. The theory advances the idea that the displaced uranium atoms diffuse preferentially in the (010) lattice direction thus causing growth in that direction. The theory predicts several causes of the effect and these as well as other theories are being checked by further experimentation.

This research is being conducted at many laboratories including the Argonne National Laboratory, Knolls Atomic Power Laboratory, Hanford Atomic Products Operation, Sylvania Electric Products Co., and North American Aviation, Inc.

Low Temperature Irradiation of Metals

The regular array of atoms in a solid is thrown into disorder by fast particle bombardment, but much of the disorder is thermally unstable even at low temperatures. To understand the detailed nature of the disordering process, it is necessary to examine both the nature of the unstable disorder and the annealing process in which order is restored.

To this end an experimental facility for the irradiation of solids at temperatures in the neighborhood of 20° Kelvin (−253° C) has been installed near the center of the Graphite Reactor at Oak Ridge. The facility consists of a refrigerated specimen chamber which is cooled by a helium refrigerator. The rate of disordering in specimens held in the reactor at a temperature of 20° K has been measured for a number of metals and alloys, using the change of electrical resistivity as an index of lattice damage. The electrical resistivity of the metal is known to increase with the lattice.

It was found that there is apparently a wide variation in both the disordering rate and the thermal stability of lattice disorder for the metals studied. The order of their increasing rates of resistivity change is: gold, copper, brass, aluminum, nickel, cobalt, iron, zinc, Cu_3Au (disordered), Cu_3Au (ordered). Appreciable amounts of the increase in resistivity could be eliminated by warming the specimen to room temperature except for iron and zinc, which require higher temperatures.

Biology and Medicine

The effects and uses of radiation are constantly under study by the Commission at its National Laboratories as well as by a large group of investigators working at Commission facilities or in the laboratories of universities, colleges, hospitals, and other research institutions.

As more and more data have been obtained it has become possible to utilize radiation beneficially in an increasingly wide variety of fields. These research studies are also supplying information which will lead to perfecting methods of protection against the harmful effects of radiation—a most important consideration in view of the increasing use of atomic energy for industrial purposes.

In this report examples of the kinds of research underway and the practical applications of such research are given. These examples cover only a small part of the overall program of medical and biological research, but are believed to be typical of the effort in that field. Other areas of participation are also reported.

Long Term Effects of Fall-Out From Nuclear Weapons

The subject of this section is necessarily one in which the conclusions may vary over a wide range. In these circumstances the Commission furnishes the following as the best estimate of its staff.

Radioactive materials disseminated in the atmosphere from large-scale use of nuclear weapons in warfare probably would affect large segments of the world's population. The Atomic Energy Com-

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mission has been keenly aware of such possibilities and has had this problem under study since 1948.

Hazards from fall-out of bomb debris would arise from two sources:

1. Exposure of personnel to radiation outside the body; i. e., radiation from radioactive fall-out lying on the ground or on other exposed surfaces, and
2. Exposure of body tissues to radiation from radioactive materials taken into the body in food, water and air.

The relative importance of these two sources of radiation would depend upon the time after detonation at which exposure is begun and upon relative precautions taken to avoid one or the other. If no special precautions were taken, it would be expected that in areas of heaviest fall-out, the external gamma radiation would be more important than the internal exposures for many weeks or months after the detonation.

The quantities of radioactivity that probably would be taken into the bodies of members of a particular population group as the result of nuclear warfare would depend upon many factors. These would include the number of weapons, the distribution of targets, fission yields and conditions of use of weapons, dissemination of weapons debris in the atmosphere and rate of deposition from the atmosphere, retention by soils, uptake by plants and animals, and biological effects of radioactive materials in the human body. Some of these factors would depend upon concurrent conditions, such as the physical and chemical nature of the bomb debris, the chemical nature and use of soils, and the dietary habits of persons affected.

Difficulties in Estimating Wartime Hazards

All of these factors enter the problem of estimating the hazards which would result from fall-out in nuclear warfare. Their evaluation involves many uncertainties, for it is very difficult to simulate for laboratory study the properties and behavior of radioactive debris from nuclear weapons. One other approach to the problem, however, lies in the fact that weapons tests to date have produced small but measurable quantities of radioactive materials in air, soil, water, foods, animals and human beings, in addition to the natural radioactivity present in the environment. Direct measurement of these quantities has been in progress for about 3 years.

Of course, many of the conditions which might affect the entry of radioactive materials into the food supply in the event of nuclear warfare would be very different from those present in nuclear testing programs. Nevertheless, some of these differences can be estimated, and their influence upon total body uptake of radioactive materials can be predicted on the basis of auxiliary laboratory and field studies.

Radioactive fission products of particular significance are isotopes of iodine and of strontium.

Since iodine concentrates in the thyroid, comparatively small quantities of radioiodine taken into the body gives the thyroid large doses of radiation. However, the potential hazard from this source is less serious than it might otherwise be due to the short half-lives of radioisotopes of iodine, to the comparative insensitivity of the thyroid to radiation, and to the possibility of survival without the thyroid.

The radioisotopes of strontium are of importance for a number of reasons:

1. They are among the more abundant of the fission products.
2. Because of their great chemical similarity to calcium, which is an essential element in the nutrition of both plants and animals, they are readily taken up and metabolized.
3. Sufficiently high concentrations of radioactive strontium in the skeleton will result in serious injury to the bone, and may lead to eventual death of the patient from cancer of the bone.
4. The half-life of one of the isotopes, strontium 90, is sufficiently long (about 28 years) so that short term protective measures, such as stockpiling of foods, would be impracticable.

The chemical and physical properties of strontium 90 permit its detection in very low concentrations. Since its occurrence in the environment is almost entirely due to its production by nuclear explosions, it is possible to determine with considerable accuracy its occurrence in soils, plants, animals, and human beings in relation to the explosions which produced it.

Concentrations of Strontium 90 in Human Bones

Assays of fragments of human bones available from routine surgical operations indicate the degree to which strontium 90 has entered the skeletons of persons of various ages. The highest concentrations have been observed in children, amounting to about one micro-microcurie (one-trillionth curie) of strontium 90 per gram of skeletal calcium. Assays of vegetation, animal tissues and milk indicate the principal paths by which strontium 90 enters the body and, with other data, provide a basis for estimating the dependence of such entry upon pertinent factors.

It is believed that skeletal concentrations of strontium 90 required to produce observable skeletal injury to human beings are several thousand times those which have been observed in the United States.

Concentrations required to produce serious injury may range from ten thousand to more than a hundred thousand times those which have been observed. These degrees of uncertainty exist because there is no specific experience involving injury to human beings by radioactive strontium. The estimates are based on long study of the effects of radium in the human skeleton, coupled with experimental studies of the comparative effects of radium and strontium 90 in animals.

Concentrations of radiostrontium in the bones of grazing animals, as a result of weapons tests to date, are found to be several times higher than in human beings, although still far below amounts which are hazardous. This difference arises largely from the fact that grazing animals obtain their needed calcium (and other food requirements), by consuming large quantities of vegetation. The radioactivity in the bones of these animals depends on the quantity of radioactive debris that has settled on the plants from the air. Humans, on the other hand, obtain more than half their calcium from milk which has been screened somewhat by the animal body to remove much of the strontium.

The Atomic Energy Commission is continuing its studies to provide data for civil defense purposes and to evaluate carefully the dangers to mankind that might result from a large-scale nuclear war.

Research Activities

Radiation Effects on Reactivation of Typhus Infection

Experiments with monkeys at the Johns Hopkins University School of Public Health indicate that moderately incapacitating doses of ionizing radiation frequently reactivate latent epidemic typhus infections in animals which had completely recovered from the disease several months prior to the irradiation. Heavy doses of cortisone may also lead to reactivation of these dormant infections. This suggests the possibility of a public health hazard, which might complicate the aftermath of a very heavy exposure of densely populated areas to nuclear radiation.

Evidence of a previous typhus infection was found in about ⅓ of a large group of Baltimoreans who emigrated from Eastern Europe some decades ago. Among those persons there has been a small number of cases of apparent reactivation of the disease following incidental treatment with cortisone or radiation.

Further analysis of this question is now planned, with extension of the study to larger similar population groups in other Eastern United States cities. This should provide more significant numbers of such persons who also happen to require cortisone or X-ray treatments, and who may be studied following treatment.

Use of Labelled Compounds in Understanding Tumor Metabolism

Peculiarities in the vital chemical processes of tumors, as revealed by radioisotopic tracing methods, are under detailed study at the Sloan-Kettering Institute in New York City. It is hoped that knowledge of differences between the metabolism of normal and cancer cells may be exploitable in the use of chemical methods for treatment.

It has been shown in rodents that different tissues in the same species (and corresponding issues in different species) utilize different quantities of various substances in building nucleic acids, and that certain interconversions of one substance to another during the process are of varying degrees of prominence in different cell types. Quite distinctive characteristics of this nature were also demonstrated by certain tumors. These observations suggest the need for further research with a view towards blocking specific chemical steps which appear to be more essential to the tumors than to the surrounding normal tissues.

Use of these isotopic techniques for comparison of the chemical behavior of tumors in different species of animals has also brought to light interesting new information on the interplay between the tumor and its host. Certain alterations in the host's own tissues, as a result of the presence of the tumors, seem to be independent of which species of host is used. The metabolism of the tumors is also modified in certain details when the tumor is transplanted from one host to another, but not to the extent of duplicating the host's own patterns.

Another study in which the use of isotopes has brought out special chemical requirements of cancer cells is being pursued at the University of Rochester Atomic Energy Project. Here it has been shown with carbon 14-labelled amino acids that a certain type of tumor has an unusually high requirement for these substances, and that growth of the tumor depends on some factor from the host's liver which is essential for maintaining a large supply of amino acids.

This lead will be developed further, as any special metabolic requirement of cancer cells not shared by normal tissues might serve as a vulnerable point for attacking the cancer with metabolic poisons.

Heavy Radiation and Psychological and Behavioral Changes

In the field of possible psychological and behavioral changes following exposure to heavy ionizing radiation, studies on rats at the University of Nebraska have been suggestive of a rather unexpected influence on the learning process. The rather heavily irradiated animals, tested in various standard puzzle situations in which a reward is given for "correct" performance, seem to "learn" the correct response more rapidly than unirradiated animals, and to "forget" a previously mastered response more slowly.

It does not appear that a true basic improvement in the learning process is involved, but rather that the injured animals are less subject to incidental distractions. They show markedly less spontaneous activity, as well as various deficits in motivation and drive which persist long after the exposure to radiation.

For some days, the irradiated rats performed poorly on previously learned tasks. However, it became apparent after the acute disturbance had subsided that during the period immediately following irradiation they had been retaining their previous training somewhat more effectively than had the nonexposed control animals (this may be associated with their relative "disinterest" in new experiences).

These differences are most clearly evident in groups of rats in which only the brain was irradiated, so that the dose could be increased to levels which would be fatal if given to the entire body. It is, of course, most unlikely that this sort of exposure would ever be met except in an artificial experimental situation; nevertheless, the observations call attention to the possibility of disturbing mental function by irradiation, and the matter is under further investigation. There is considerable interest in studying possible alterations in mental performance resulting from radiation exposure during embryonic development, rather than after the brain and nervous system have attained the adult form.

Studies on Steroid Metabolism

Long-range studies at the Worcester Foundation for Experimental Biology, in Shrewsbury, Mass., have made a major contribution to the understanding of the chemical transformations involved in the production and utilization of the steroid hormones of the adrenal cortex.

By means of special isotopic methods for labelling and tracing these substances, and other micro-assay methods developed on this project, it has become feasible to follow the chemical steps in the turnover of the adrenal cortical steroids within the animal body, where the naturally occurring amounts of these important hormones are very minute. Many hitherto unknown details of the synthesis and metabolism of these substances, and the activities of the enzymes concerned, have been brought out in these studies.

There is also work underway on the problem of the disturbance of these metabolic processes by exposure of the animal, or of the isolated adrenal gland, to ionizing radiation. Some specific alterations have already been demonstrated and it is hoped to clarify this further by investigating what role these disturbances may play in the overall reactions of the body to irradiation.

Radiation Experiments With High-Energy Proton Beams

At the University of California at Berkeley, high-energy irradiation with protons or deuterons from the cyclotron is under evaluation as a means of treating various special cancers. Primary emphasis in this program has been on the use of radiation to suppress the activity of the pituitary gland, so as to dispense with the serious hazards of pituitary surgery in those cancer patients in which removal of this gland is desirable.

Accelerated high-energy charged particles (such as protons or deuterons) are especially suitable for localized irradiation of small volumes of tissue situated relatively deep within the body, as the beams penetrate satisfactorily and travel practically in a straight line, producing a rather sharply delimited area of radiation effects. Less scatter to neighboring parts is encountered than with other types of radiation used at present in clinical radiology.

Exploratory work on this project was carried out on about 1,000 young rats, in which the functional state of the pituitary gland can be estimated in a variety of ways. Rats whose pituitary glands had been removed surgically served as controls against which to evaluate the effectiveness of the radiation as a means of suppressing or destroying the gland. Doses were given in amounts of 3,200 to 31,500 reps (roentgens equivalent physical) by directing a pencil beam of deuterons laterally through the pituitary of the rats.

The animals' development was then closely followed, and at autopsy the pituitaries and most of the other endocrine glands were weighed and studied microscopically. Some of the rats which survived the highest doses showed a complete failure to gain in weight and length as did the controls in which the pituitary had been removed by surgery.

Only by giving extremely high doses of radiation (25,000 reps or more) was it possible to bring about complete cessation of pituitary function within a few days. At lower doses (12,600 reps or less) the pituitary and the various glands which it regulates continued to increase in size for some time and then proceeded to undergo atrophy. The greater the dose, the earlier the onset of the atrophy. Body growth and thyroid growth were impaired soon after irradiation at each dose level, but degeneration of the testes occurred much later.

There was no evidence of stimulation of any function of the anterior pituitary with the doses and periods of observation employed in this study, nor of recovery of the pituitary after being damaged at any of the dose levels employed. The different cells of the anterior pituitary were found to be almost equally sensitive to irradiation.

Pursuant to this basic study, promising tests of the method were made on dogs and other animals suffering from mammary carcinomas or other cancers of the type which may be benefitted by pituitary inactivity.

At last report, 30 patients, including 28 in advanced stages of cancer, have had their pituitary glands irradiated with protons. Evidence of good suppression of pituitary function has been obtained and a number of the patients have shown considerable relief.

Radiation Effects on Life Expectancy

At the University of Rochester Atomic Energy Project there are underway a variety of studies expected to improve our understanding of the effects of long-range chronic exposure to radiation at levels not immediately or obviously damaging. This type of investigation is essential to maintenance of a radiation protection program throughout the widespread nuclear energy enterprise.

One facet of the general problem under investigation is the effect of radiation in shortening life expectancy. Certain basic hypotheses about the quantitative relation between life-span and the amount and timing of radiation exposure are under test in rats and mice.

For example, a recent series of experiments demonstrated that a single large dose of radiation shortens life-expectancy in rats to a greater degree than an equivalent total dose given piecemeal over a 10-day period. Due to the statistical nature of the problem, large numbers of a homogeneous population of animals must be used in such experiments, and these must be followed under controlled conditions for their full life spans. Thus the complete analysis will require long continuation of the program.

Radiation Effects on Productivity

The need for protection from repeated small doses of X-rays was recognized early in the history of radiology, although not early enough to prevent the occurrence of skin and crippling hand lesions, which were frequent among the earliest workers in the field. The expanded development and peacetime use of nuclear energy has made it advisable to obtain data on the long term biologic effects of repeated small doses of irradiation.

It is especially important to test experimentally, in a biologically suitable long-lived animal species, the possible effects of the present maximum permissible exposure level for human beings for chronic X- and gamma-radiation (0.3 r/week), and of other dosage levels in this range, on extremely radio-sensitive physiologic processes such as spermatogenesis and reproduction.

The Atomic Energy Project at the University of Rochester is conducting a life-term experiment on thoroughbred male beagle dogs to determine long-term effects of small daily doses of X-rays on the production of sperm. Three experimental groups receive weekly X-ray doses of 0.3, 0.6, and 3.0 roentgens respectively, and a control group is maintained. At regular intervals semen is sampled, sperm counts are made, and samples are examined microscopically for abnormalities.

Since the effects on fertility are the real concern, the sperm data are supplemented by mating each irradiated dog with an unirradiated proved female. To date these dogs have been X-irradiated for periods of from 2 to 4 years. At 10 times the maximum permissible weekly rate for man, the irradiation produced sterility in most of the dogs within one year. The absolute sperm count began to decline progressively after 20 to 30 weeks of exposure, and reached levels less than 10 percent of normal within a year. Moderate or marked increases in the percentages of morphologically abnormal, immotile, and dead sperm reduced further the numbers of normal sperm. With continuing irradiation these conditions have persisted.

No reduction in fertility has been observed so far in the group receiving the maximum permissible exposure rate or the group receiving twice that rate. Many of these dogs have shown small increases in the percentages of certain abnormalities of sperm. No conclusion can be drawn at this time regarding the possible relation of these changes to irradiation. They are being studied mostly for significant development, and functional effects. This experiment will be continued for the lifetime of the dogs. Later in the experiment the dogs will be studied for other possible effects, including cancer production, acceleration of aging processes, and life shortening.

Tracer Studies With Plants

Argonne National Laboratory is continuing its biosynthesis program, in which carbon 14 and other radioactive isotopes are being incorporated into plants for the purpose of furnishing labelled compounds for medical, biological, agricultural and industrial research. One example of these studies is given below.

C–14 rubber studies. The assimilation of carbon and the biosynthesis and turnover of rubber in rubber trees (*Hevea brasiliensis*) was investigated in cooperation with the U. S. Department of Agriculture and the Quartermaster Corps, United States Army. Rubber seedlings and old stumps which had released new shoots were grown in the Argonne chamber in an atmosphere containing radioactive carbon dioxide. These experiments supplied information on formation and turnover of rubber which will be available for use in various technological studies.

The radioactive carbon was found first in leaf rubber and only later in stem rubber. Up to now, it was thought that rubber formation occurs only in the bark. It appears now that the leaf not only possesses the complete biochemical pathway for rubber formation, but that it also may be the chief source of a specific substance required for rubber formation at other places in the plant.

A field study was carried out in cooperation with the Federal Experiment Station, U. S. Department of Agriculture, Mayaguez, Puerto Rico. The experimental evidence suggests that the radioactive carbon assimilated by rubber trees is formed initially into high molecular weight rather than low molecular weight rubber.

Other studies were designed to determine whether rubber once formed in the plant is later broken down. The data suggest that starved plants may metabolize at least a fraction of the formed rubber.

In the course of these investigations, a quantity of C^{14} labelled rubber will be formed. It will be released to the Quartermaster Corps for distribution and use in tracer studies on the breakdown or degradation of rubber in rubber products under varied environmental conditions.

Portions of the tissues from the radioactive rubber plants have been sent to the New South Wales University of Technology in Australia, where an attempt to isolate and identify the inositols present in the tissues will be made. Inositols are sugarlike compounds found naturally in many plant and animal tissues; in some chemical forms they act as vitamins (part of the B complex). Portions of the purified compounds will be returned for distribution to other investigators. The use of the labelled inositols promises to give useful information both in plant and in animal studies.

Uptake of Strontium by Plants

The interest of the Atomic Energy Commission in the uptake of fission products by plants and animals is directly related to peacetime development of atomic energy for power. It is recognized that our knowledge of how these elements enter into the food chain must be well developed.

One of the studies being conducted along these lines is concerned with the uptake and utilization by plants of the natural (nonradioactive) strontium that occurs in our soils. Information gained from this investigation will be useful in studies of the uptake of radioactive strontium.

Investigators have determined the calcium and strontium contents of about 100 crop samples of wheat and alfalfa, and the corresponding soil samples taken from 12 states. The total contents of calcium and strontium in the plant samples were determined. In the soil samples from the plow layer, the amounts of calcium and strontium exchangeable with neutral normal ammonium acetate solution were determined.

The data on exchangeable calcium and strontium show the differences in contents which may be encountered in different areas. The amounts of exchangeable strontium and calcium in the soil are highly correlated. However, the ratio varies with location, from 0.5 atoms of strontium per 1,000 atoms of calcium in northern Illinois and southern Wisconsin to 3 atoms of strontium per 1,000 atoms of calcium in Nebraska and Oregon.

The distribution of the ratio of atoms of strontium per 1,000 atoms of calcium show differences with respect to the parent material of the soil. While this difference is small, those soils derived from igneous and limestone materials, in general, are more fertile and contain larger quantities of calcium.

Since the plant samples had virtually the same ratio of strontium to calcium as was found in the ammonium acetate extract of the soil on which the plants were grown, it may be inferred that plants grown on the more fertile soils will have a relatively high strontium content. It cannot, however, be concluded that the radioactive strontium which may enter the soil will follow this same pattern. This question remains to be determined.

The possibility of fixation of strontium by soils is being investigated. A recent investigation indicates that some of the added strontium is more or less fixed. The addition of lime to the soil tends to increase slightly the fraction that is fixed. The data suggest that when strontium is added to soils relatively high in limestone, a large fraction of the strontium may be expected to be in a less soluble state. This will tend to counterbalance the previously observed data indicating a higher uptake of native strontium from soils inherently high in calcium.

Radiation Induced Mutations in Plants

Studies at Brookhaven National Laboratory have been underway for several years to test the possibility of using radiations to produce useful mutations in plants. When a mutation is produced in a plant, it means that a new variety has been created. It is only necessary tc screen the new varieties and select the ones having desirable properties.

Mutations are produced by subjecting the growing plants to gamma radiation in the Brookhaven "gamma field" or subjecting seeds or cuttings to X-rays, or to neutrons in the thermal column of the Brookhaven reactor.

Improved varieties have already been obtained in such plants as the small grains, in which it is economically feasible to discard numerous plants carrying deleterious mutations in order to recover the relatively few plants showing improvement. One of the first important mutations produced was one in which the Mohawk variety of oats, which is normally very susceptible to an oat rust disease, was rendered resistant to the disease without changing any of its other quantities. This variety has now bred true for five generations.

A number of other interesting mutations have been produced, among them a variety of oats with shorter, stronger straw and wider leaves which may have considerable practical importance. A number of the new varieties differ in only minor ways from the parent varieties but are valuable for breeding purposes.

It was found that blight resistance in oats can be induced very easily, but the new variety is usually susceptible to rust diseases although the parent variety was not. Thus these two diseases must involve closely associated characteristics of the plant, and a study of the genetic properties of these diseases is giving a profound insight into the nature of disease resistance in plants.

Production of new varieties by radiation-induced mutations has been tried before with almost no success because it was not recognized that the exact control of dosage is extremely important. In order to make the results of new research available to agriculturists as soon as possible, Brookhaven initiated a cooperative research program with universities, agricultural experiment stations and the U. S. Department of Agriculture with a view to the development of new crop varieties.

Under this program, the laboratory interested in a particular crop works out a program in consultation with Brookhaven scientists. The seeds, cuttings or whole plants or trees are then irradiated at Brookhaven with the appropriate radiation and sent back to the originating laboratory to be grown and screened for desirable mutations.

This program has already yielded some very important results. A variety of wheat has been produced which gives a very high yield and is resistant to one form of wheat rust, a disease which has caused a crop loss in the middle west of many millions of dollars annually. A variety of rice has been produced which has short, strong straw which will withstand wind damage which often devastates the Texas rice crop. A variety of flax has been produced which is resistant to a prevalent flax rust disease. There are now over 100 such projects in progress, many of which are producing this sort of result.

Nematode Research

Cooperative research between Brookhaven National Laboratory and the U. S. Department of Agriculture Nematode Research Laboratory has shown that relatively small doses of radiation will produce sterility in nematode worms. Nematode infections are very serious in many crops such as potatoes and strawberries. By irradiation of the potatoes from an infected area, it would be possible to prevent the spread of the infection and also to prolong the storage life of the potatoes by preventing them from sprouting (see pp. 57–58, Sixteenth Semiannual Report, January–June 1954).

This finding leads to the possibility of controlling a number of nematode infections by the use of radiation. For example, such infections in strawberries are usually passed along with new plants, so by irradiation of the plants before planting, it should be possible to maintain a field free of infection. Preliminary investigations along this line are very encouraging.

Radiation Injury in Plants

Many aspects of the effects of radiation on plants have been studied and important information has been obtained. Recent investigations at Argonne National Laboratory were designed to give more precise information on the mechanisms by which radiation produces plant injury. The results of many experiments have suggested that growing tissues are more sensitive to radiation than are nongrowing tissues. It is also well known that shortages or excesses of certain mineral elements in plants result in reduction of metabolic activity and retardation of growth; for example, the absence of boron, even for short periods, decreases cellular activity and arrests growth.

To scientists at the Argonne Laboratory these facts suggested that it might be profitable to investigate the effects of boron on the radiosensitivity of plants. In normal sunflower plants exposed to X-ray (1000r), typical radiation symptoms—speckling, mottling, and distortion—appeared in all the subsequently developed leaves (26 to 28 pairs) up to 70 days later; in addition, growth was retarded. In boron-deficient sunflower plants, leaf damage was observed only in the first six to seven pairs of leaves, and recovery thereafter was complete. These plants were considerably less stunted.

The results of this study indicate also that the same experimental approach may well be used to obtain more information on the roles of boron and other essential mineral elements in the growth of plants.

Photomultiplier Tube Development

The scintillation counter technique which was introduced shortly after World War II has progressed so rapidly that it is now the most effective and versatile method for the detection and measurement of nuclear radiations and particles. The method depends on the interaction of radiations with special materials known as scintillators, in which minute flashes of light are generated in proportion to the energy of the incident nuclear ray. These individual flashes are "viewed" by a photomultiplier tube which converts the light into small electrical impulses and then amplifies them to levels readily utilized by electronic techniques.

The scintillation counter detects radiation much faster and with greater efficiency than the Geiger counter or ionization chamber. Counting efficiencies approaching 100 percent are realizable and phenomena occurring in one-one hundred millionth of a second can be analyzed.

Two new photomultiplier tubes developed under contract for the Commission are now being produced in quantities and will shortly be readily available. The two tubes offer new applications for scintillation counting techniques.

One is a 16-inch photomultiplier tube developed by the Allen B. DuMont Laboratories. Its application for gamma-ray spectrometry with either large solid fluors or liquid scintillators opens new fields of experimentation and measurement. The other tube, developed by the Radio Corporation of America, is a 2-inch photocathode, high gain linear, multiplier phototube. It was designed for applications in high speed measurements of nuclear events required for the study of phenomena associated with high energy accelerators. Two of these tubes were used successfully in the instrumentation employed in the recent discovery by University of California Radiation Laboratory scientists of the antiproton.

Monitoring of Marine Food Products

Following the underwater defense test detonation of a small fission device in the eastern Pacific this past spring, the Atomic Energy Commission, in cooperation with the Federal Food and Drug Administration, established a monitoring system on the west coast to detect any possible presence of radioactivity in marine food fish as a result of the detonation.

Anchovies, mackerel, tuna, and sharks (livers and fins) caught in the general area off California and Mexico, were monitored. Automatic survey counting and recording equipment was installed on the conveyor lines at the large fish canneries. Hand monitoring was conducted at the smaller canneries by trained Food and Drug Administration inspectors.

From the beginning of the program in mid-May to its termination in early August, 49,514,500 pounds of fish were monitored. The monitoring program confirmed the previous announcement that the test involved no health hazard to mainland or island inhabitants or consumers of fish.

Civil Defense Liaison Activities

Increased emphasis during this reporting period was placed on developing the most effective means of providing additional scientific and technical support to the Federal Civil Defense Administration in furtherance of the Commission's long standing policy of support to the national civil defense program. This effort included the following activities.

Operation ARME

"Operation ARME", an aerial radiological monitoring exercise, was conducted at the Nevada Test Site by the Atomic Energy Commission during the week of October 17, 1955, for Federal Civil Defense Administration-sponsored personnel. The objective was to acquaint the participants, representing FCDA, state and local radiological defense organizations, with aerial survey techniques and equipment developed by the Health and Safety Laboratory, New York Operations Office, for monitoring large water and land areas adjoining continental and overseas test sites. The aerial survey instrumentation included an airborne detector, an altitude compensator and a telemetering unit to transmit information to a remote ground station.

The successful completion of this exercise demonstrated the technical feasibility of aerial radiological survey techniques. The Federal Civil Defense Administration will utilize the experience gained to develop criteria and guidance in radiological monitoring for civil defense applications in connection with fall-out from nuclear attack.

Selected shot areas in Yucca Flat, Nevada Test Site, were surveyed by aerial and ground teams to determine the level of activity and distribution of the low-level radiation remaining principally from the May 5, 1955 "Open Shot". The exercise provided a basis of comparison of aerial and ground survey operations and results.

The operational program included briefings and field familiarization with the component parts of the air and ground monitoring methods and equipment, including mobile radar for tracking the survey aircraft. A total of 27 persons took part in Operation ARME, including 13 FCDA and U. S. Public Health Service personnel, 9 representing state and local civil defense organizations, and 5 from AEC.

AEC-FCDA Conference

A 2-day conference on "Nuclear Effects and Civil Defense" was held in Chicago in late October to sum up the state of knowledge of nuclear effects applicable to civil defense research problems and applications of weapons effects data. The meeting covered the main areas of physical damage to civilian structures and the modes of occurrence of such damage; biomedical effects, including blast biology, prompt and residual radiation and radiation effects on foodstuffs; and measurement and evaluation of radiological contamination.

AEC staff members and experts from various Commission contractors discussed these subjects, drawing upon civil effects projects of Operation TEAPOT (spring 1955, Nevada Test Site), as well as earlier atomic weapons tests and results of other field and laboratory research. Forty-eight persons attended this conference, including 34 from the Federal Civil Defense Administration.

Dissemination of Civil Effects Information

Thirty-seven preliminary reports have been issued covering each of the projects carried out by the Civil Effects Test Group, during Operation TEAPOT. Seventeen of these were issued as unclassified reports with wide distribution resulting in many cases.

Final reports, completing description and evaluation of each civil effects project, are under preparation. Emphasis is being placed upon elimination or segregation of classified information wherever possible, so that release of a large mass of information on the civil effects of nuclear detonations can be made to state and local civil defense organizations, architects, engineers, the medical profession, and to the public.

In addition, classified reports in this area of information resulting from all past test operations, both Pacific and continental, are being reviewed for possible declassification. These reports total several hundred. Classified weapons effects reports are routinely provided the Federal Civil Defense Administration by the AEC and Department of Defense under prescribed security safeguards.

International Affairs

The Commission is authorized under the Atomic Energy Act of 1954 to perform specific activities in the field of international cooperation to "promote the common defense and security and to make available to cooperating nations the benefits of peaceful applications of atomic energy."

The increased interest of foreign nations in atomic energy development, and the new obligations of the AEC resulting from the provisions for international cooperation in the new law led the Commission to establish on November 13, 1955, a Division of International Affairs.

The new division is responsible for developing and directing a program of international cooperation in the area of peaceful applications of atomic energy to the extent authorized by the Atomic Energy Act of 1954 and consistent with United States policy. The program includes coordination of AEC activities relating to the various types of agreements for international cooperation, including those covering the sale or lease of nuclear or special materials; assistance on matters relating to the proposed International Atomic Energy Agency; international scientific conferences on atomic energy developments and related projects.

Technical advice and assistance will be provided other nations, as authorized, through the exchange of technical and nontechnical reports, AEC libraries, arrangements for visits of foreign nationals to AEC headquarters and field installations, their participation in specialized training courses at AEC centers or cooperating universities, and the use of materials and equipment.

In addition, the division will also maintain liasion with the Department of State and other Government agencies concerned with international affairs and foreign officials regarding atomic energy matters. This will include direct participation with the Department of State on proposals presented to the United Nations involving atomic energy such as disarmament and the study of ionizing radiation.

International Cooperation Program

Specific accomplishments for the 6 months' period of this report under the international program are reported below.

Agreements for Cooperation

Negotiations leading to agreements for cooperation in the civil uses of atomic energy were undertaken with 27 countries. Fully effective agreements for cooperation were completed with 22 countries by Dec. 31. Agreements relating to the exchange of unclassified information on design, construction, and operation of research reactors include the countries of Argentina, Brazil, Colombia, Chile, Denmark, Greece, Israel, Italy, Japan, Lebanon, Netherlands, Pakistan, the

Philippines, Portugal, the Republic of China, Spain, Switzerland, Turkey, and Venezuela. Agreements with Belgium, Canada, and the United Kingdom pertain to the exchange of restricted data and information on power reactors.

Five other agreements—with Korea, Peru, Sweden, Thailand, and Uruguay—are before the Joint Committee on Atomic Energy pending completion of the statutory 30-day waiting period.

Following the International Conference on the Peaceful Uses of Atomic Energy at Geneva in August, other countries indicated a desire to undertake negotiations with the United States on atomic energy development. Accordingly, after the Conference, arrangements were made for preliminary discussions and visits for representatives of interested countries with AEC personnel. Also, on the last day of the Conference, the AEC formally transferred the research reactor exhibited there to the Swiss government, as reported in the earlier section on the Conference.

Exchanges With Other Nations

The flow of information on atomic energy between the United States and other nations is aided by the exchange of visitors which provides opportunities for person-to-person discussions.

During this reporting period, approximately 398 classified visits were arranged within the framework of United States agreements for cooperation with Belgium, Canada, and the United Kingdom, as reported below. In addition, 357 representatives of other nations interested in atomic energy development have come to the United States during 1955 for unclassified discussions or have made unclassified visits to Washington or AEC installations. Classified conferences totaled 164; 113 held in the United States, 35 held in Canada, and 16 held in the United Kingdom. Classified visits to facilities included 84 United States representatives to Canada, 124 United States representatives to United Kingdom, 94 Canadian representatives to the United States, 72 United Kingdom representatives to the United States, and 6 Belgian representatives to AEC installations.

These totals included visits to the United Kingdom's research center at Harwell, England, by 95 United States scientists and engineers following the Geneva Conference. Most of the United States visitors were members of the United States Delegation to the Conference and the British invitation to come to Harwell was one of the first activities taken under the agreement for cooperation between the two nations. The United States members were afforded a broad opportunity to learn through laboratory observations and discussions with the Harwell staff of the various fields of atomic energy research and development of mutual interest to both nations.

Belgian Government representatives, in connection with their agreement, visited Washington and AEC installations. The discussions centered on the type of power reactor suitable for construction in Belgium; an engineering test reactor, a power reactor suitable for the forthcoming World Fair in Brussels in 1958, and personnel training needs.

The unclassified visits were planned to provide informal discussions for foreign nationals with AEC personnel, and to allow first-hand observations of atomic energy activities at field installations. The 357 visitors included representatives from 33 nations, including Argentina, Australia, Austria, Belgium, Brazil, Burma, Republic of China, Colombia, Denmark, Egypt, Finland, France, West Germany, Greece, Haiti, India, Indonesia, Israel, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Pakistan, Philippines, Portugal, Spain, Sweden, Thailand, Turkey, Union of South Africa, United Kingdom, and 11 foreign nationals from various countries employed by the USIA.

United Nations Activities

Geneva Conference

There were four projects involving the United Nations in which the Commission cooperated closely with the Department of State in providing technical assistance. The first was the successful International Conference on the Peaceful Uses of Atomic Energy held at Geneva, Switzerland, August 8–20, 1955. At the request of the Department of State, the Commission carried the major burden in the organization and presentation of the United States contribution to this historic meeting and a more detailed account is given earlier in this report.

On December 3, 1955, the General Assembly of the United Nations approved the recommendation of its Political and Security Committee that a second international conference on atomic energy applications be held under auspices of the United Nations in 2 or 3 years.

International Atomic Energy Agency

Progress has been made on the draft statute for an International Agency which was originally negotiated by the Governments of the United States, Belgium, Canada, France, the United Kingdom, Portugal, Australia, and the Union of South Africa. Early in July, the Union of Soviet Socialist Republics stated its willingness to contribute fissionable material to such an agency, if established, and the draft was forwarded to it for review.

The draft statute in the meantime had been sufficiently developed to make it appropriate to solicit the views of other States. Accordingly, copies were transmitted by the Department of State in August on a confidential basis to all states members of the United Nations or its specialized agencies for comments.

The United Nations General Assembly adopted on December 3, 1955, the resolution of its Political and Security Committee which endorsed the progress made in establishing an International Atomic Energy Agency and approved the continuance of exchange of technical information on peacetime uses of atomic energy.

The United States issued invitations to consider the text of the draft statute at a meeting of a working level group in Washington. The invitations went to the Governments of Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Portugal, the Union of South Africa, the Union of Soviet Socialist Republics, and the United Kingdom.

In November, a preparatory meeting was held of the 12-nation working group and general agreement was reached on an agenda, and procedures for the meeting scheduled in February.

Disarmament

The Commission served with other Government departments in an advisory capacity to assist the United States delegation to the United Nations in the 5-nation subcommittee of the United Nations Disarmament Commission. Meetings of the subcommittee were held in New York throughout September.

Resolution on Ionizing Radiation

Growing interest on an international scale was shown in the subject of the effects of ionizing radiation on man and his environment due in part to weapons test activities, and in part to the developing widespread uses of atomic energy for peaceful applications. A resolution on this subject, developed and sponsored by the United States and seven other countries, was adopted on December 3 by the United Nations General Assembly. The AEC assisted the Department of State in preparing the draft resolution.

The resolution establishes a Scientific Committee to receive and collate in appropriate and useful form, reports from States members of the United Nations and of its specialized agencies. These reports will include data on the effects of observed levels of radioactivity in the environment, and on scientific observations or experiments relevant to effects of ionizing radiation on man and his environment. The resolution provides for Committee membership of one representative from each of the following countries: Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, Egypt, France, India, Japan, Mexico, Sweden, the United Kingdom, the United States, and the Union of Soviet Socialist Republics.

The Committee is requested to recommend uniform standards with respect to procedures for sample collections of radioactive materials, instrumentation, and radiation counting procedures for analyses of samples. It is also requested to make yearly progress reports and to develop by July 1, 1958, or earlier if the assembled facts warrant, a summary of the reports received.

Sale of Nuclear and Special Materials

On the day the Geneva Conference opened, August 8, 1955, the Commission announced a value for enriched uranium leased to cooperating nations under the bilateral agreements. Sale prices also were set for normal uranium and heavy water. The leased value of uranium enriched to 20 percent in uranium 235 (and not exceeding a total of 6 kilograms) was placed at $25 per gram of the contained uranium 235. Normal uranium metal was priced at $40 a kilogram and heavy water at $28 per pound.

This lease-sale schedule is part of the AEC's support of the Atoms-for-Peace program. The figures are as near as the Commission could estimate the costs of these materials and represent neither a subsidy to other nations nor a profit to the United States.

Under this schedule, the Commission recently approved the sale of up to 7 tons of heavy water to Reactor, Ltd., a private Swiss firm, for an experimental research reactor. The request was endorsed by the Swiss Government. Beginning in February 1955, the Commission also has approved sales of heavy water to the United Kingdom, India, Australia, Italy, and France.

Training and Education [4]

School of Nuclear Science and Engineering. On October 14, a total of 30 students from 19 countries completed the first session of the School of Nuclear Science and Engineering, operated by the Argonne National Laboratory, near Chicago, Ill.

[4] Initial courses in these schools and the names of the participating countries are shown in the Eighteenth Semiannual Report to Congress (January-June 1955).

The second course, also comprising 7 months' training, began November 7, 1955, with 40 nationals from 21 other countries enrolled. This makes a total of 70 foreign students from 29 countries who have had the opportunity to take these courses.

Courses in radioisotope techniques. Beginning October 17, 1955, 31 scientists from 21 countries enrolled in the second special course in radioisotope techniques to be held by the Oak Ridge Institute of Nuclear Studies specifically for students from other countries. The course consisted of 4 weeks' training and was similar to that given to United States students in regular sessions.

Tours of United States facilities. In June, the first group of doctors, surgeons, and biological scientists from foreign nations visited atomic energy laboratories, and United States hospitals and universities to observe the uses of ionizing radiation in the treatment of disease, such as cancer, and general medical applications. In a second group of 13 visitors who began a similar 5-week tour on October 17, 1955, there were representatives from Burma, Chile, Ecuador, France, Guatemala, Indonesia, Lebanon, Luxembourg, Paraguay, Portugal, Turkey, and Uruguay.

Technical libraries. During the interval covered by this report, the Commission approved the presentation of technical libraries to 10 additional nations, and three international organizations. Thus a total of 36 libraries containing comprehensive compilations of unclassified nuclear energy data have been contributed to date.

The new libraries will be located in Brazil, Chile, Dominican Republic, Haiti, Lebanon, Pakistan, Republic of China, Switzerland, Thailand, Uruguay, and in UN headquarters in New York, and UN and CERN installations in Switzerland.

Civilian Application

The Commission's program for encouraging the participation of private enterprise in the development of the civilian uses of atomic energy gained further momentum during the period covered by this report. Proposed regulations were published in the *Federal Register* for public comment.

The interest of private organizations and individuals in obtaining access to restricted data on civilian uses continued to be demonstrated by a constant flow of applications for access permits from a wide variety of industries, trades, and professions. To assist permittees to obtain information in fields of interest, the Commission held seminars and similar meetings for representatives of interested companies.

Regulations

Proposed regulations on licensing of operators of production and utilization facilities, radiation protection, and rules of practice were published in Federal Register (under Notice of Rule Making), so that the public might have an opportunity to comment on them before they became effective. A number of helpful comments and suggestions on these three regulations, and the four proposed regulations previously published, were received. Work is continuing on the revision of the proposed regulations in light of these comments and further staff studies. A regulation on operator's licenses was published in the *Federal Register* January 4, 1956, to become effective in 30 days. Other regulations were scheduled to follow rapidly.

In connection with the proposed regulations prescribing standards for protection against radiation hazards, the Commission has established an advisory committee of State officials as a means of obtaining the views and suggestions of State regulatory agencies on regulatory problems of public health and industrial safety (see Appendix 2).

Access Program

In order to make classified atomic energy information available to organizations and individuals for their private uses, the Commission started the Access Permit program on April 20, 1955. Under this program, private individuals or organizations may obtain permits for access to either Confidential or Confidential and Secret Restricted Data, depending on their needs.

As of December 31, 1955, AEC had received 686 applications for permits and 602 permits had been issued. Of the issued permits, 430 were for access to Confidential Restricted Data only. The remainder were for Secret Data in certain limited categories of information.

Access permits were issued to companies in all parts of the country, from most segments of industry, and from companies which have expressed interest in many phases of atomic energy activity as indicated by the listing below:

DATA ON ACCESS PERMITS ISSUED THROUGH DECEMBER 31, 1955

GEOGRAPHIC DISTRIBUTION

New England	57	West South Central	23
Middle Atlantic	225	Mountain	16
East North Central	118	Pacific	50
West North Central	41	Hawaii, Alaska, and Puerto Rico	3
South Atlantic	60		
East South Central	9	Total	602

BUSINESS OR OCCUPATION

Metal Mining and Refining	21
Metal Products Manufacturing	107
Chemical and Petroleum Manufacturing	56
Instrument Manufacturing	42
Engineering and Construction	57
Utilities and Associated Companies	132
Research Organizations	30
Consultants	56
Banks and Investing Companies	17
Insurance Organizations	25
Educational Institutions	11
Others not elsewhere classified	48
Total	602

FIELD OF INTEREST

Operating Atomic Facilities	
Reactors for production of electric power	133
Reactors for other purposes such as research, propulsion of ships, etc	28
Plants to refine uranium and thorium ore and process feed materials	39
Chemical plants for reprocessing spent fuel elements	21
Manufacture of Atomic Energy Products	
Entire reactors	40
Components such as fuel elements, instruments and pumps for reactors and related facilities	123
Materials for atomic energy applications such as zirconium, carbon and special alloys	49
Related Activities	
Utilizing radioactive isotopes for sterilization of food, radiochemistry, research, etc	38
Design and construction of atomic energy facilities	56
General nuclear research	28
Consulting on atomic energy problems	54
Investing and lending capital	16
Evaluating insurance risks	27
Others not elsewhere classified	63

NOTE.—These figures include permit holders with more than one field of interest, resulting in a total greater than the number of permittees.

The permit holders must obtain security clearances for such of their personnel as will require access and establish suitable arrangements for storage of classified material and for security education before they may receive any classified documents. After fulfilling these requirements, permit holders and their employees may receive classified matter and discuss classified topics with other cleared people, As part of the AEC program to foster development of a private atomic energy industry, several meetings were conducted by the Reactor Development Division and the Division of Production to present technological information of interest to companies planning atomic energy activities.

In July 1955, the first symposium on fuel processing was held at the Oak Ridge National Laboratory with about 200 representatives present from industrial processing companies and utilities interested in nuclear power. The sessions were classified and open to companies with either access permits or study agreements. Descriptions of the ORNL Metal Recovery Plant, an irradiated thorium processing plant and the Idaho Chemical Processing Plant were presented along with cost data to give the visitors a basis for comparing costs of commercial plants with reactor fuel processing plants.

The Argonne National Laboratory reported on research and development of the boiling water and fast breeder reactor systems at a meeting November 1–2 at the National Reactor Testing Station in Idaho. A seminar on the liquid metal fueled reactor concept was held by the Brookhaven National Laboratory at the laboratory site on Long Island on November 21–22. Between 200 and 300 access permit holders attended these sessions.

An unclassified discussion of problems relating to the development and construction of the Pressurized Water Reactor Plant at Shippingport, Pa., was conducted at Pittsburgh, Pa. on December 2, attended by officials and technical people from industrial firms, electric utilities, banking and investment firms and insurance companies.

Certain materials and services required for the civilian uses of atomic energy are presently available only from the Commission. The Commission has developed and is countinuing to develop pricing and allocation schedules to provide the necessary materials and services for the peacetime atomic energy industry.

Activities of U. S. Companies in Foreign Atomic Energy Programs

In October, the Commission, pursuant to Section 57 a (3) (B) of the 1954 Act, announced a general authorization under which United States companies and individuals may engage in unclassified activities in foreign countries without specific approval of the Commission. The only limitations are that the authorization does not apply to those countries listed as Subgroup A countries or destinations in Section 371.3 of the Comprehensive Export Schedule of the Department of Commerce (see Appendix 6), that the activity does not involve the communication of restricted data or other classified defense information, and is conducted in compliance with other applicable provisions of law.

The bilateral agreement for cooperation with Canada has been implemented in nine instances to allow private commercial firms of the countries to collaborate in activities which involve the communication of restricted data or other unclassified defense information.

Licensing Activities

Applications for licenses to construct production and/or utilization facilities were received from the following:

Cook Electric Co., Chicago, Ill.—for construction and operation of a facility for the fabrication of fuel elements. Construction of the facility was approved.

The Babcock and Wilcox Co., New York, N. Y.—for construction and operation of a fuel element fabrication facility and a critical assembly facility, both at the company's site near Lynchburg, Va. Construction of both facilities was approved.

Metals and Controls Corp., Attleboro, Mass.—for construction and operation of a fuel element fabrication facility. Construction of the facility was approved.

Battelle Memorial Institute, Columbus, Ohio—for construction and operation of a critical assembly facility at West Jefferson, Ohio. A construction permit was issued. The Institute was also issued a construction permit covering the construction of a modified "swimming pool" type research reactor to operate at 1,000 kilowatts.

Applied Nucleonics Corp., Walnut Creek, Calif.—for construction and operation of a research reactor to operate at a power level of 100 milliwatts.

A license to operate a research reactor, also of the "swimming pool" type, was issued to Pennsylvania State University. Construction of this reactor was started before enactment of the Atomic Energy Act of 1954.

A formal license was issued to North Carolina State College for operation of the Raleigh Research Reactor. The college previously operated the reactor under a contract and interim licensing arrangement with the Commission.

Applications to receive and possess special nuclear material were received from the following:

Atomic Power Development Associates, Inc., Detroit, Mich. In connection with its research and development activities relating to nuclear power reactors, this organization applied for an allocation of and appropriate licenses for 15 kilograms of uranium enriched to 10 percent in the isotope uranium 235 and 2,000 kilograms of normal uranium and uranium depleted in the isotope uranium 235.

Glenn L. Martin Co., Baltimore, Md. This application is for an allocation of 18 grams and a license to possess 50 grams of contained uranium 235 for use in fuel element research and development.

Nuclear Development Corporation of America, White Plains, N. Y. This firm applied for a license to authorize the possession of two kilograms of uranium enriched up to 30 percent in the isotope uranium 235 for irradiation studies relating to fuel element research.

The Babcock and Wilcox Co., New York, N. Y. This application is for a license to possess 50 grams of uranium 235 for use in a breeder element test loop for obtaining data relating to the construction of the Consolidated Edison Reactor, and to possess the uranium 233 resulting from irradiation of a small quantity of thorium.

University of Michigan, Ann Arbor, Mich. The University applied for authorization to receive four spent MTR fuel assemblies and a license to possess these assemblies to investigate the methods and effects of using them as high intensity gamma irradiation sources in biological and other processes.

In addition to those indicated above licenses authorizing the receipt and use of special nuclear materials were issued to Battelle Memorial Institute, Columbus, Ohio; Nuclear Science and Engineering Corp., Pittsburgh, Pa.; and Rensselaer Polytechnic Institute, Troy, N. Y.

Eleven applications for operator licenses were received; however, only three applications contained all the required information. Licenses were issued in those cases.

Source Material Licenses

A total of 1,874 source material licenses were issued or renewed during the calendar year 1955. These include 885 to producers, 28 to processors, 79 to distributors, 167 to consumers, and 715 to exporters.

Facility Component Licenses

Effective September 26, 1955, the Commission relinquished the AEC controls administered since 1947 with respect to the export of certain facility components. The specific items involved were (1) radiation detection and measurement instruments, (2) mass spectrometers, mass spectrographs and mass spectrometer-type leak detectors, (3) large vacuum diffusion pumps, and (4) certain types of electro-nuclear machines. Concurrently with this action by the Commission, the U. S. Department of Commerce assumed export licensing jurisdiction with respect to these items. During the period January 1 to September 26, 1955, the Commission issued 3,480 export licenses authorizing shipments of these types of instruments and equipment.

Insurance on Privately Owned Nuclear Facilities

In July the group of insurance company executives previously formed to consider the problems involved in providing insurance protection on privately owned nuclear facilities submitted a preliminary report. The group is continuing its study of the insurance problem and expects to submit its conclusions early in 1956.

Information for Industry

As an indication of rising industrial interest in atomic energy development average daily sales of AEC unclassified technical reports have increased to nearly four times the 1954 levels. The daily average was 218 in September 1954; and 833 in September 1955.

To service the industrial access permittees, as well as individuals and firms interested only in unclassified information, the AEC has inaugurated an accelerated industrial information program to provide written and graphic information including unclassified and classified data on nearly every phase of science and technology developed within the national atomic energy program, excepting weapons technology and certain other limited defense-sensitive matters.

Program activities initiated or expanded to increase the dissemination of information include unclassified and classified documentary sales services, technological advisory service, a writing program and a drawing sales program.

Documentary Service

The AEC's documentary service for industry includes both classified and unclassified materials. Sales for unclassified documents are handled by the Office of Technical Services, Department of Commerce. Some 2,000 AEC unclassified reports are now available in full-size copy and reports are being added to the collection at the rate of 10 to 15 reports per working day. Price lists of these reports are available from the Office of Technical Services, Department of Commerce, and an availability list of 12,000 reports on atomic energy which have been published in "Nuclear Science Abstracts," has been compiled and made available for sale as "Cumulated Numerical List of Available Unclassified U. S. Atomic Energy Reports."

The reactor handbooks and other volumes specifically prepared for the Geneva Conference, unclassified nuclear power study team reports, bound volumes of "Nuclear Science Abstracts," Joint Committee on

Atomic Energy Hearings, and other general interest publications may be purchased from the U. S. Government Printing Office.

From Microcard Foundation, through special arrangements with AEC, some 9,000 AEC unclassified reports included in "Nuclear Science Abstracts" are now available as microcopy in card form.

Under the AEC classified documentary service, the Commission has authorized an expedited review for downgrading or declassification of approximately 20,000 classified reports in central files of the Technical Information Service at Oak Ridge. This review is scheduled to be completed by March 1956 (see Classification). Industrially significant reports will be made available as unclassified, confidential, or secret to the permit holders as soon as appropriate reproductions can be accomplished.

A document sales agency has been established at Oak Ridge to effect an efficient and equitable distribution of classified information to permit holders. Sales are on a cash remittance system and order forms are available to cleared firms from AEC Technical Information Service, Oak Ridge.

As a regular announcement of report availability, the AEC has begun publication of a new monthly confidential abstract journal entitled, "Civilian Applications of Atomic Energy." The standard classified abstract journal, "Abstracts of Classified Reports" is available to those permitted access to secret material.

Persons granted access permits receive immediately a listing of all available unclassified materials. When personnel and facilities clearances have been completed, the permit holders are apprised of all classified information available to them.

Technological Advisory Service

Access permittees are notified of and encouraged to utilize services provided by the staff of the Industrial Information Branch. Technological advisors provide information to the access permit holder on where work is being accomplished, who is doing the work, progress in various fields of research and general oral and/or written technical assistance.

Writing Program

Despite broad dissemination, the AEC recognizes limitations of existing materials. Since this material was prepared to inform project personnel of scientific advances rather than to present a complete compilation of technological data to new firms probing for industrial applications, a writing program calculated to collect and collate the best information on broad subject areas important to atomic energy fields has been initiated.

Work has begun on books to introduce the newcomer to the atomic energy field, to cover the technical considerations in reactor control and safety, and to cover known techniques and costs involved in disposal of fission products including important individual species. Both classified and unclassified versions will be prepared if necessary to cover the fields. Unclassified books are to be prepared on production of uranium and classified books on fuel fabrication techniques.

Drawings Program

As still another phase of the information dissemination program for industry, the AEC has provided engineering drawings such as those for the Oak Ridge Research Reactor. As the demand for such graphic materials increases, the Technical Information Service will make known the availability of selected sets of drawings to all who qualify to purchase them.

Technical Information Service has cooperated with the Division of Civilian Application and other responsible divisions in planning and conducting briefing sessions, including the printing and distribution of reports and transcripts of these meetings. As additional firms are cleared under the access program, orientation and technical briefings will be arranged to provide on-the-spot information.

The Technical Information Service has participated in commercial exhibits and professional meetings, providing speakers, exhibit materials, technical advice, and direct contact for the AEC with industrial representatives interested in becoming informed of technical data available from the AEC.

Classification

Declassification of Information

The Commission puts its basic classification policy into effect through the Declassification Guide for Responsible Reviewers prepared by the Division of Classification for Commission approval. This Guide spells out by means of topics the types of information which may and may not be declassified, and assigns an appropriate classification to each topic.

The Commission is continually aware of the growing and changing needs of science and industry for the information in its possession.

In the periodic revisions of the Guide a fine balance must be struck between protecting information which is of national security interest and providing the maximum assistance to peaceful applications.

Revisions to the Guide take into account the information in the possession of the United Kingdom and Canada. Through annual tripartite declassification conferences the three nations keep their declassification rules consistent.

The beneficial results of keeping the Declassification Guide up to date by the United States to meet changing needs were illustrated by the content of the papers presented at the International Conference on the Peaceful Uses of Atomic Energy. During the previous year, and before such a conference was proposed, the rapidly growing interest of U. S. industry in power reactors had occasioned a searching look at the Guide to find where it might be changed without endangering national security.

Large areas of reactor information were recognized as no longer requiring maximum security protection, and proposals to revise the Guide accordingly were made at a tripartite conference in October 1954. The new rules were put into effect in April 1955.

The declassification of information entails more than the making of rules and fixing of policy. The information must be found in tangible form, handled, and evaluated, and the rules must be applied in the actual physical review of individual classified documents.

Reports are written for operational reasons and generally are directed toward a technical purpose requiring data from various technical fields. Because of this many reports contain information that must remain classified as well as information that can be released. In addition some information that is of interest in civilian applications of atomic energy has great value to production or military application programs and cannot be declassified. For these reasons, the review of individual reports is necessary. Reports cannot be classified or declassified on a block basis.

The present rules, since April 1955, have applied to the review of information currently arising in the atomic energy program. They also affect earlier information residing in classified papers and reports in files throughout atomic energy projects. The new rules have made thousands of these declassifiable or at least eligible for downgrading to Confidential—in fact, a rapid survey of report holdings for material of potential value to peaceful uses disclosed more than 20,000 reports which under the current rules should be reviewed for declassification or downgrading.

Special Review Project

The Commission is aware of its obligation to evaluate this material and, where possible, make it available. The doing of this, however, involves a review of large proportions.

In the normal procedure, a report proposed for declassification is reviewed as to security and appropriateness of content by the Coordinating Organization Director at the particular site. It then goes to a Responsible Reviewer, a scientist foremost in the particular field, who reviews it in light of the Declassification Guide and determines its appropriate classification. Finally, the report is reviewed by the Declassification Branch of the Division of Classification and, if the other reviews have indicated that such action is warranted, it is downgraded from Secret to Confidential or is declassified and made available for distribution.

A special program was first initiated in April 1955 and then greatly expanded in November 1955 to speed up the review of the backlog of reports mentioned above. Some 35 technically trained people, on loan from the various AEC and contractor installations, were gathered as a reviewing team at Oak Ridge under supervision of the Division of Classification.

With the Declassification Guide furnishing the working rules, this team has processed reports at a rate of more than 2,000 per week. Of the first 6,000 reviewed, approximately one-third were declassified, one-third were downgraded from Secret to Confidential and one-third retained their original classification. It appears that the same proportions will apply to the entire 20,000 reports when the review work is completed in March 1956.

As part of the same overall review program, all major installations are conducting a continuing and thorough search of their files for additional information that may be of value to peaceful uses. Moreover, current reports are being reviewed as they are prepared, so that as many as possible may become immediately available.

Circumstances change continuously and, even while the revised classification rules and criteria are thus being applied, steps are being taken toward meeting the growing need for further revision.

Opinions are obtained from the AEC's Committee of Senior Reviewers, an advisory group of recognized experts in the various phases of the atomic energy projects. Subcommittees on weapons, reactors, and chemistry and metallurgy, are consulted to advise the AEC of their views as to security sensitivity of information in these fields. The needs of industry for certain kinds of information are also determined. With all such material accumulated, Atomic Energy Commission is again preparing revisions to the Guide.

Nuclear Materials Management

Peaceful Uses of Special Nuclear Materials

In connection with proposals for international peaceful uses of atomic energy, information was provided to several governmental groups studying the measures necessary to maintain appropriate accountability over the special nuclear materials required.

Tentative procedures were developed to facilitate distribution and control of special nuclear materials to be used in domestic peaceful applications, in anticipation of increased requirements for such materials.

Responsibility for compiling information on material requirements for all peaceful uses was centralized in the Division of Nuclear Materials Management.

Annual Meeting Change

The fifth annual meeting of AEC personnel to discuss accountability matters included for the first time a joint AEC-contractor session. The scope of future meetings will be broadened to include similar joint sessions on chemical and physical measurements, auditing and accounting, in addition to mathematical statistics.

Policy Review

The review of material management policy, projected in the previous semiannual report, has been initiated. Purpose of the review is to ascertain what policy changes, if any, are necessary in view of the increased volume and scope of Commission activities. Attention is being directed to possible need for differences in policy regarding licensees and contractors.

The financial incentive of licensees, in terms of charges for loss or use of material, presents an additional consideration. In this regard an evaluation is being made of the types of chemical reference standards needed as an aid to appropriate determination of quantities of materials transferred and on inventory.

Inspection

A statement of inspection policy applicable to AEC officers and employees and to contractors was approved by the General Manager. In connection with the important task of preparation of technical

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inspection standards and procedures, the collaboration of outstanding and experienced persons in the field of reactor technology is being sought.

Compliance Activities

An incident involving a fuel leak in the North Carolina State College reactor was investigated and the Division of Inspection collaborated in technical evalution of the difficulty and formulation of remedial action.

Two official inspections were performed on the Pennsylvania State University reactor facility prior to and during initial operation.

The Geneva installation and its operation were inspected prior to the opening of the Conference. Other inspections included:

The Bulk Shielding Facility, the X–10 Graphite Reactor, the Low Intensity Test Reactor, and the Tower Shielding Facility at Oak Ridge; the Materials Testing Reactor in Idaho, following an increase in normal power level; and the University of Michigan reactor, which is under construction.

Management Review

At the request of the General Manager a broad review of the policy and systems for accounting for source and special nuclear materials was undertaken.

Discussions were conducted with staff and program divisions for the purpose of encouraging the development of integrated field inspection programs. A continuing review of inspection reports compiled by staff divisions and operations offices was initiated by the Division of Inspection. A review of the systems of inspection utilized by headquarters offices and divisions is being conducted.

Construction and Supply

Construction activity continued to taper off during the first half of fiscal year 1956. During this period, capital investment in atomic energy facilities increased $155 million, bringing the total to $6.64 billion, before depreciation reserves. Monthly construction costs averaged about $26 million, a decrease of nearly 55 percent from the $57 million per month for the previous 6-month period. It is expected that costs will average about the same during the second half of fiscal year 1956.

Present construction activity continues to be mainly of production plant facilities. However, there was increasing construction activity in connection with reactors of civilian and military significance, and such work is expected to become increasingly important in the construction program. During the past 6 months, work started on the Engineering Test Reactor at Idaho and on the Submarine Advanced Reactor test facilities at West Milton, N. Y.

New Headquarters Office Building

Public Law 31, 84th Congress, First Session, approved May 6, 1955, authorized the Atomic Energy Commission to construct a new headquarters building in or near the District of Columbia. After considering approximately 50 potential sites as a location, the Commission announced on July 29, 1955, that a site near Gaithersburg, in Montgomery County, Maryland about 23 miles northwest of downtown Washington had been selected for the building. It is planned that construction will be completed in the latter part of 1957.

Records Management

During fiscal year 1955 significant progress was made in the AEC records management program. This is the first year during which records disposal has exceeded records growth. A total of 94,414 cubic feet of records were disposed of, 105 percent of the volume generated during the year and an increase of 28 percent over the 1954 disposal rate.

Interchange of Scientific Facilities by Government Agencies

Certain unclassified AEC scientific equipment and facilities have been listed as available for use by other Federal agencies to the extent practicable and consistent with AEC work requirements. Designed to help this agency interchange, an inventory report, "Major Scientific Facilities and Equipment of U. S. Government Laboratories," was prepared by an Interdepartmental Committee established by Executive Order 10521. The Committee has as its broad objective the strengthening of the national scientific effort.

AEC's implementation of the report provides for (1) cooperation in making AEC-listed equipment and facilities available for other agency use and (2) use of the report to locate possible sources of supply to meet AEC needs for additional equipment or facilities.

Ore Freight Rates

Negotiations with western rail carriers to establish a lower scale of freight rates from potential ore-producing areas in Oregon, California, and Nevada to Kalunite, Utah, and other processing points have resulted in a number of reductions ranging from 10 percent to 33 percent of the original rates. Negotiated in the interest of increasing uranium ore supply, such reductions are normally an incentive to ore production in the areas involved.

Small Business

Maximum practicable small business participation continued to be emphasized at each AEC operation and cost-type contractor purchasing office in line with the Congressional small business policy restated in the Small Business Act of 1953, as amended August 9, 1955, that a fair proportion of total supplies and services be procured from small business.

The rate of small business participation in AEC procurement increased in fiscal year 1955. During that period the subcontract dollars going to small business amounted to 46.6 percent of a total of $338.3 million. From July 1, 1951, to September 30, 1955, AEC cost-type contractors awarded $2.63 billion in subcontracts and of this amount $1.03 billion or 39.1 percent went to small business. Direct contract awards to small business during the same period amounted to $202 million or 3.2 percent of the total amount of AEC contracts ($6.274 billion).

Community Operations

Community Disposal

The Atomic Energy Community Act of 1955 was signed by the President on August 4. It provides for the disposal of federally owned properties at the communities of Oak Ridge, Tenn., and Richland, Wash., and prescribes a basis for the establishment of self-government by the residents of the communities.

To carry out the Act, all properties at both Oak Ridge and Richland have been classified and plotted. The Federal Housing Administration has established offices at both locations and is proceeding with the appraisals of all real property which is to be offered for sale.

The Commission published, in the *Federal Register* of November 22, 1955, a proposed regulation to establish priority of purchase, allowing 30 days for comment. Comments were accepted until December 22, 1955, and the regulation was expected to be issued during January.

The Commission has recommended that all sales and financing functions under the Act be delegated to another Federal agency. A total of 123 single residential lots, previously leased by competitive bid, have been offered for sale under provisions of the Atomic Energy Community Act of 1955.

The transfer of municipal installations to the new municipalities or other entities is not contemplated prior to fiscal year 1958. An application to purchase the community telephone system at Hanford has been received from the General Telephone Co. of the Northwest. The Commission is studying this application and possible transfer of other utilities under the criteria specified in the statute.

Housing and Community Facilities

Oak Ridge. A new "downtown" commercial center financed privately and built on land leased from the Government on a long-term basis, was opened officially on October 6, 1955, with 216,000 square feet of floor space available. Thirty-one business establishments were opened, 20 of them new to Oak Ridge. By the end of the year another 81,000 square feet of space had been added to the center.

Other areas. The Public Housing Administration on September 30 discontinued operation of the Waverly, Ohio, project of 400 temporary housing units provided for the construction workers at the Portsmouth plant. PHA contemplates discontinuance of all temporary housing activities in the Portsmouth area by March 31, 1956.

Finance

The financial report [5] of the Atomic Energy Commission for fiscal year 1955 contains more detailed financial information than the Commission has made public in previous years, including summaries of costs by years for 1950–55 inclusive in the major AEC program activities.

This latest financial report shows the financial position of AEC at June 30, 1955 and June 30, 1954, the results of operations for the fiscal years ended on these dates, and a summary of the history of the Nation's investment in the atomic energy program from June 1940 through June 1955.

Appropriations to AEC and its predecessor organizations for fiscal years 1940 through 1955 total $14.4 billion. AEC assets shown in the balance sheet total $9.1 billion at June 30, 1955. For security rea-

[5] See Appendix 8.

sons, the assets shown in the published report do not include assets in the form of inventories of stockpiled products.

Plant and equipment in use reached a new high as progress in the plant expansion program authorized in fiscal year 1952 to achieve greater productive capacity brought the completed plant and equipment total to $5.9 billion at June 30, 1955. This compares with a total of $4.1 billion at June 30, 1954. As a result of completion of major projects included in this expansion program, construction work in progress decreased to $629 million at June 30, 1955 from $1,615 million at June 30, 1954.

Operating costs rose to $1.3 billion for fiscal year 1955 from $1 billion for fiscal year 1954 as new production plants came into operation, ore receipts increased, and greater efforts were devoted to developing reactors.

Organization and Personnel

Personnel and Organizational Changes

In a recess appointment, the President named Harold S. Vance on October 10 to fill the existing vacancy on the Commission.

Dr. Charles L. Dunham, formerly Deputy Director, Division of Biology and Medicine, was appointed Director of the Division replacing Dr. John C. Bugher who will continue to serve the AEC on the Advisory Committee on Biology and Medicine. Charles L. Marshall, formerly Deputy Director, Division of Classification, was appointed Director of the Division replacing Dr. Charles D. Luke, who has been appointed Technical Assistant for Reactor Hazards Evaluation.

John A. Hall, formerly Director, Office of International Affairs, was appointed Director of the newly established Division of International Affairs.

Kenner F. Hertford was appointed Manager, Santa Fe Operations Office, effective October 1, 1955, replacing Donald J. Leehey.

James E. Travis succeeded David F. Shaw (transferred to headquarters as Assistant General Manager for Manufacturing) as Manager, Hanford Operations Office, effective August 1, 1955.

Organization and Management

Several rather significant organization studies were made during the past 6 months.

Rapid development of Commission responsibilities growing out of the expanding Atoms-for-Peace Program of the President led to the establishment on November 13 of a Division of International Affairs. This new unit is charged with the development of the AEC international cooperation program in the area of peaceful applications of atomic energy. In carrying out this function, the new Division will coordinate the program among other interested AEC Divisions and offices, with the Department of State and other agencies and with representatives of foreign nations. The former Office of International Affairs was absorbed in the new Division.

The Commission contracted with McKinsey and Co., a private management consulting firm, to study the adequacy of the organizational and administrative arrangements that have been made by the AEC to encourage the development of peaceful uses of atomic energy.

The Commission published, in manual form, guides on the principles and standards of organization planning. These will aid key staff throughout the Commission in the development or modification of plans on organization.

Regulations on Advisory Boards

The Commission published regulations setting forth the scope, procedure and limitations of the authority of advisory boards established by the Commission pursuant to Section 161a of the Atomic Energy Act of 1954. The Commission also issued instructions setting forth policies and criteria for the employment and compensation of individual consultants and members of advisory groups.

Incentive Awards

The incentive awards program was expanded through the establishment of special AEC honor awards and provisions for recognition of length of service and retirement. The special honor awards are the Distinguished Service Award and the Outstanding Service Award.

The AEC Distinguished Service Award had been granted to five individuals. They were as follows:

Name	*Position*	*Date Presented*
Walter J. Williams	Deputy General Manager	January 28, 1954
Lawrence R. Hafstad	Director, Division of Reactor Development.	December 21, 1954
Roy B. Snapp	Secretary to the Commission	February 28, 1955
K. D. Nichols	General Manager	April 28, 1955
John C. Bugher	Director, Division of Biology and Medicine.	September 22, 1955

Total Federal service is recognized at 10-year intervals, following completion of 1 year of AEC service, and retirement awards are presented to employees who retire after 20 or more years service.

Cash and honorary awards may be granted for suggestions having tangible or intangible benefits, for superior performance, or special acts of service. There has been a steady increase in activity in this program. The results during the first 7 months, March 1 to September 30, 1955, were as follows:

	Suggestions	*Superior Performance*	*Total*
Received	131	60	191
Approved	17	[a] 27	44
Rejected	76	11	87
Pending	38	22	60

Cash Awards

	Number	*Amount*	*Net 1st Year Savings*
Superior Performance	25	$8485	----------
Suggestions	17	1530	$263, 108. 46

[a] 25 cash awards, 2 honorary.

Two AEC career employees, Don S. Burrows, Controller, and Samuel R. Sapirie, Manager, Oak Ridge Operations Office, were among the ten Federal Government employees selected for the first annual Career Service Awards made by the National Civil Service League on December 2, 1955. The winners were selected "because they exemplify in an outstanding manner the primary characteristics of the career service—competence, efficiency, character, and continuity of service." The ten recipients were chosen from over 100 nominations made by 33 Federal agencies.

AEC and Contractor Employment Trend

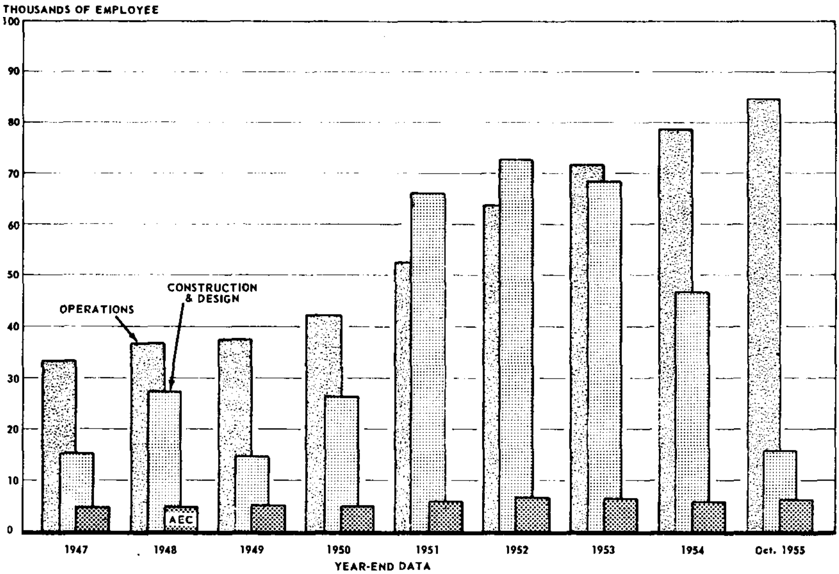
Direct employment of the Atomic Energy Commission totaled 6,154 in October 1955, gaining slightly during the past 6 months due largely to increased emphasis on the civilian application program and raw materials exploration activities.

Employment by operating contractors totaled 84,747 in October, gaining about 6,600 since the beginning of 1955. The most significant increases were experienced by: ACF Industries; Bendix Aviation Corp.; Holmes & Narver; duPont—Savannah River; General Electric Co.—Hanford and Lockland; Westinghouse Electric Corp.; and University of California—Berkeley. Smaller gains are forecast during future months.

Employment is expected to reach about 87,000 by June 1956, leveling off at about 90,000 toward the end of 1957.

Employment by construction and design contractors engaged in AEC work totaled 15,949 in October. A 43 percent reduction has occurred in this category during the past 6 months and a 73 percent reduction during the past year. Current employment in this phase of the AEC program is the lowest in 5 years. Further declines are anticipated during the coming year but at a slower rate. The year-end construction employment estimates for 1956 and 1957 are forecast to be about 14,000 and 12,000 employees, respectively.

AEC & CONTRACTOR EMPLOYMENT



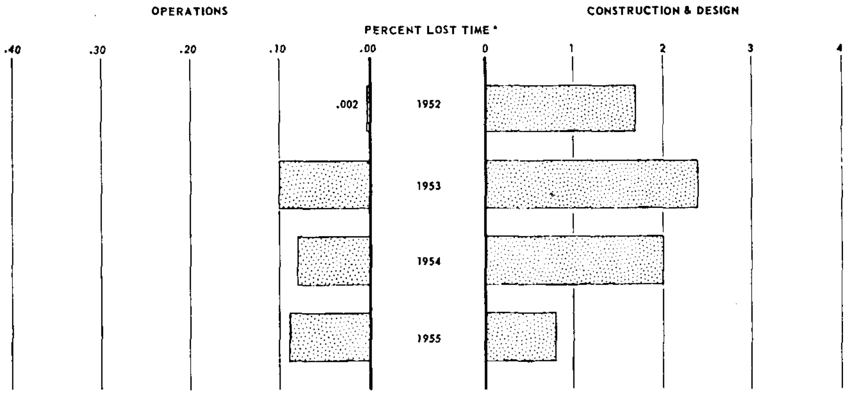
Work Stoppages

There was a marked decrease in the time lost due to labor-management disputes in construction and design activities during the calendar year 1955. The percentage of time lost in relation to working hours scheduled was 0.8 percent compared to 2.0 and 2.4 percent for 1954 and 1953, respectively. The most significant loss occurred at Oak Ridge in July as a result of a general widespread strike in the area over wage negotiations. Although most of the idleness during the year occurred at Oak Ridge, the percent of time lost to scheduled hours at the project has decreased substantially from 4.4 percent in 1954 to 3.0 percent in 1955.

Between January and November 1955, there were three stoppages in operations activities which resulted in a loss of 0.09 percent of the scheduled working time. The percentage of time lost during the corresponding period of 1954 was 0.08 percent.

The most serious was a stoppage involving employees of Sandia Corp., Albuquerque, N. Mex., in a dispute over renewal terms of labor agreements, which was settled with the assistance of the Atomic Energy Labor-Management Relations Panel. Organized employees of ACF Industries, Inc., Buffalo, N. Y., walked out in June in protest of the discharge of an employee. A dispute over contract renewal terms initiated a second stoppage at ACF which began on October 3. With the aid of the Federal Mediation and Conciliation Service this strike was terminated on October 5.

CONTRACTOR WORK STOPPAGE



* Percent lost time of scheduled work time.

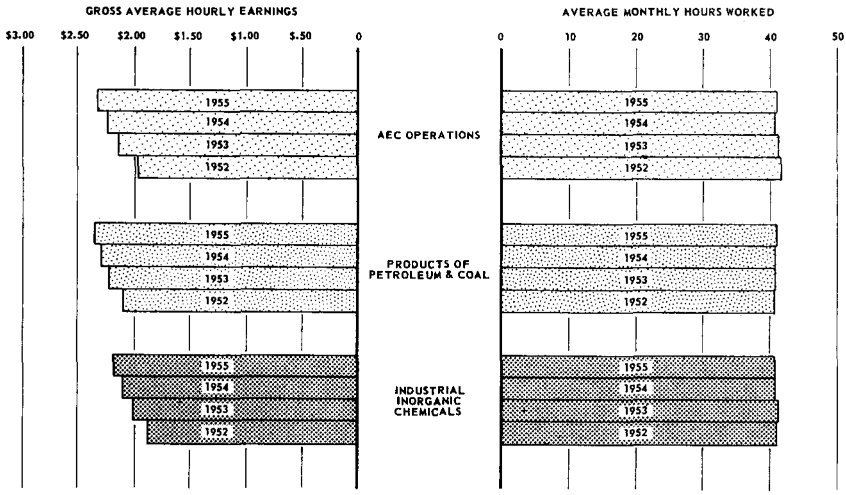
Earnings and Hours

Gross earnings of atomic energy production and related workers averaged $2.37 per hour in September, the latest month for which data are available. Over the first 9 months of 1955, earnings of these workers have increased 4.4 percent as compared to 5.0 percent and 10.9 percent during the same periods of 1954 and 1953, respectively.

In industries considered most comparable to AEC in process and equipment, the rate of increase was greater than in atomic energy during the year—6.1 percent in products of petroleum and coal and 5.1 percent in industrial inorganic chemicals. However, average earnings in atomic energy continue to fall between the two industries, the September average being 5 cents below that of petroleum and coal products and 12 cents above the chemicals industry.

During the year the average number of hours worked per week by employees in atomic energy was 40.9; in products of petroleum and coal, 41.0; and in industrial inorganic chemicals, 40.8.

GROSS AVERAGE HOURS & EARNINGS



AEC and Contractor Safety Experience

There was an overall reduction of 21 percent in the number of injuries per million man-hours to the end of October 1955 from the 1954 experience for the same 10 months.

	Injuries per Million Man-Hours		
	Jan. through Oct. 1955	*Jan. through Oct. 1954*	*Change in Percent*
All Activities	1.92	2.43	−21.0
Construction	2.98	2.70	+11.0
Operations	1.60	2.23	−28.3
Government (AEC)	2.01	2.03	−1.0

The severity of injuries (measured by duration of work time lost) also decreased from 580 days lost to 365 days lost per million man-hours worked. This reduction in severity rate reflects the fact that fewer fatal accidents occurred than in the same period of 1954. Dollar losses from fires and explosions continue at a low rate, despite the occurrence of a serious explosion at the Y–12 plant at Oak Ridge, Tenn., on June 17, 1955.

During the period from July 1 to October 31, 1955, 13 Awards of Merit and 4 Awards of Honor were presented to contractors with outstanding safety experience.

Twenty-seven serious incidents were reported during the same 4-months' period, involving personal injuries, fires, property damage, motor vehicle accidents and unscheduled interruptions of operations. More complete reporting since February 1955 reveals that spills of radioactive material occur more frequently and at greater cost than previously indicated.

There has been an increase in the development of promotional materials in accident and fire prevention, and an increasing demand from private industrial and insurance interests to obtain technical data on accident and fire prevention.

A classified "Summary of Accidents and Incidents Involving Radiation in Atomic Energy Activities From June 1945 through December 1954" was prepared for use in evaluating the experience in hazards peculiar to atomic energy operations. An unclassified version is being edited for use in the civilian application program.

APPENDIX 1

Organization and Principal Staff of U. S. Atomic Energy Commission

Atomic Energy Commission	Lewis L. Strauss, *Chairman.*
	Willard F. Libby.
	Thomas E. Murray.
	Harold S. Vance.
	John von Neumann.
Assistant to the Chairman	McKay Donkin.
Assistant to the Chairman	Manuel Dupkin II.
Assistant to the Chairman	Everett Holles.
Assistant to the Chairman	Cmdr. Charles E. Nelson, USN.
General Manager	K. E. Fields.
Deputy General Manager	R. W. Cook.
Special Assistant to General Manager (Liaison)	Paul F. Foster.
Special Assistant to General Manager	Charles Vanden Bulck.
Special Assistant to General Manager (Congressional)	William C. Wampler.
Assistant General Manager	Harry S. Traynor.
Assistant General Manager for Administration	J. L. Kelehan.
Assistant General Manager for Manufacturing	David F. Shaw.
Assistant General Manager for Research and Industrial Development	A. Tammaro.
Controller	Don S. Burrows.
General Counsel	William Mitchell.
Secretary to Commission	W. B. McCool.
Chief, Office of Operations Analysis	C. D. W. Thornton.
Director, Division of Biology and Medicine	Dr. Charles L. Dunham.
Director, Division of Civilian Application	Harold L. Price.
Director, Division of Classification	C. L. Marshall.
Director, Division of Construction and Supply	John A. Derry.
Director, Division of Information Services	Morse Salisbury.

Director, Division of Inspection	CURTIS A. NELSON.
Director, Division of Intelligence	C. H. REICHARDT.
Director, Division of International Affairs	JOHN A. HALL.
Director, Division of Military Application	Brig. Gen. ALFRED D. STARBIRD, USA.
Director, Division of Nuclear Materials Management	D. F. MUSSER.
Director, Division of Organization and Personnel	OSCAR S. SMITH.
Director, Division of Production	E. J. BLOCH.
Director, Division of Raw Materials	JESSE C. JOHNSON.
Director, Division of Reactor Development	W. KENNETH DAVIS.
Director, Division of Research	T. H. JOHNSON.
Director, Division of Security	JOHN A. WATERS, Jr.

MANAGERS OF OPERATIONS OFFICES AND AREAS:

Chicago (Ill.) Operations Office	J. J. FLAHERTY.
Hartford Area	ERNEST B. TREMMEL.
Lockland (Ohio) Area	E. M. VELTEN.
Pittsburgh (Pa.) Area	LAWTON D. GEIGER.
Grand Junction (Colo.) Operations Office	SHELDON P. WIMPFEN.[1]
Hanford (Wash.) Operations Office	JAMES E. TRAVIS.
Idaho (Idaho Falls) Operations Office	ALLAN C. JOHNSON.
New York (N. Y.) Operations Office	MERRIL EISENBUD.
Brookhaven (Long Island, N. Y.) Area	E. L. VAN HORN.
Oak Ridge (Tenn.) Operations Office	S. R. SAPIRIE.
Fernald (Cincinnati, Ohio) Area	CLARENCE L. KARL.
New Brunswick (N. J.) Area	C. J. RODDEN.
Paducah (Ky.) Area	KENNEDY C. BROOKS.
Portsmouth (Ohio) Area	KENNETH A. DUNBAR.
St. Louis (Mo.) Area	FRED H. BELCHER.
San Francisco (Calif.) Operations Office	HAROLD A. FIDLER.

[1] ALLAN E. JONES has been designated Manager, Grand Junction Operations Office, effective February 1, 1956.

MANAGERS OF OPERATIONS OFFICES AND AREAS—Continued

Sante Fe (Albuquerque, N. Mex.) Operations Office	KENNER F. HERTFORD.
Dayton (Miamisburg, Ohio) Area	JOHN H. ROBERSON.
Kansas City (Mo.) Area	JAMES C. STOWERS.
Los Alamos (N. Mex.) Area	PAUL A. WILSON.
Rocky Flats (Colo.) Area	GILBERT C. HOOVER.
Savannah River (Augusta, Ga.) Operations Office	ROBERT C. BLAIR.
Dana (Terre Haute, Ind.) Area	CHARLES W. REILLY.
Schenectady (N. Y.) Operations Office	JON D. ANDERSON.

APPENDIX 2

Membership of Committees

STATUTORY COMMITTEES

Joint Committee on Atomic Energy—Eighty-fourth Congress

This committee was established by the Atomic Energy Act of 1946, and continued under the Atomic Energy Act of 1954, to make "continuing studies of the activities of the Atomic Energy Commission and of problems relating to the development, use, and control of atomic energy." The committee is kept fully and currently informed with respect to the Commission's activities. Legislation relating primarily to the Commission or to atomic energy matters is referred to the committee. The committee's membership is composed of nine members of the Senate and nine members of the House of Representatives.

Senator Clinton P. Anderson (New Mexico), *Chairman.*
Senator Richard B. Russell (Georgia).
Senator John O. Pastore (Rhode Island).
Senator Albert Gore (Tennessee).
Senator Henry M. Jackson (Washington).
Senator Bourke B. Hickenlooper (Iowa).
Senator Eugene D. Millikin (Colorado).
Senator William F. Knowland (California).
Senator John W. Bricker (Ohio).
Representative Carl T. Durham (North Carolina).
Representative Chet Holifield (California).
Representative Melvin Price (Illinois).
Representative Paul J. Kilday (Texas).
Representative John J. Dempsey (New Mexico).
Representative W. Sterling Cole (New York).
Representative Carl Hinshaw (California).
Representative James E. Van Zandt (Pennsylvania).
Representative James T. Patterson (Connecticut).

Military Liaison Committee

Under Sec. 27 of the Atomic Energy Act of 1954, "there is hereby established a Military Liaison Committee consisting of—a. a Chairman, who shall be the head thereof and who shall be appointed by the President, by and with the advice and consent of the Senate, who shall serve at the pleasure of the President, and who shall receive compensation at the rate prescribed for an Assistant Secretary of Defense; and b. a representative or representatives from each of the Departments of the Army, Navy, and Air Force, in equal numbers, as determined by the Secretary of Defense, to be assigned from each Department by the Secretary thereof, and who will serve without additional compensation. The Chairman of the Committee may designate one of the members of the Committee as Acting Chairman to act during his absence. The Commission shall advise and consult with the Department of Defense, through the Committee, on all atomic energy matters which the Department of Defense deems to relate to military applications of atomic weapons or atomic energy including the development, manufacture, use, and storage of atomic weapons, the allocation of special nuclear material for military research, and the control of information relating to the manufacture or utilization of atomic weapons; and shall keep the Department of Defense, through the Committee, fully and currently informed of all such matters before the Commission. The Department of Defense, through the Committee, shall keep the Commission fully and currently informed on all matters within the Department of Defense which the Commission deems to relate to the development or application of atomic energy. The Department of Defense, through the Committee, shall have the authority to make written recommendations to the Commission from time to time on matters relating to military applications of atomic energy as the Department of Defense may deem appropriate. If the Department of Defense at any time concludes that any request, action, proposed action, or failure to act on the part of the Commission is adverse to the responsibilities of the Department of Defense, the Secretary of Defense shall refer the matter to the President whose decision shall be final."

Hon. HERBERT B. LOPER, *Chairman.*
Brig. Gen. JOHN P. DALEY, United States Army.
Maj. Gen. HARRY McK. ROPER, United States Army.
Rear Adm. GEORGE C. WRIGHT, United States Navy.
Rear Adm. PAUL H. RAMSEY, United States Navy.
Maj. Gen. HERBERT B. THATCHER, United States Air Force.
Brig. Gen. RICHARD T. COINER, Jr., United States Air Force.

General Advisory Committee

This committee was established by the Atomic Energy Act of 1946 (Sec. 2 (b)), and is continued by Sec. 26 of the Atomic Energy Act of 1954. The nine civilian members are appointed by the President to advise the Commission on scientific and technical matters relating to materials, production, and research and development. Under the Atomic Energy Act, the committee shall meet at least four times in every calendar year.

Dr. I. I. RABI, chairman; professor of physics, Columbia University, New York, N. Y.
Dr. JESSE W. BEAMS, professor of physics, University of Virginia, Charlottesville, Va.
Dr. J. B. FISK, executive vice president, Bell Telephone Laboratories, Murray Hill, N. Y.
Dr. WARREN C. JOHNSON, dean of physical sciences, University of Chicago, Chicago, Ill.
Dr. EDWIN M. McMILLAN, professor of physics, UCRL, Berkeley, Calif.
EGER V. MURPHREE, president, ESSO Research and Engineering Co., New York, N. Y.
Dr. J. C. WARNER, president, Carnegie Institute of Technology, Pittsburgh, Pa.
WALTER G. WHITMAN, head, department of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass.
Dr. EUGENE P. WIGNER, professor of physics, Princeton University, Princeton, N. J.
Dr. RICHARD W. DODSON, secretary; chairman, department of chemistry, Brookhaven National Laboratory, Upton, Long Island, N. Y.

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PATENT COMPENSATION BOARD

This board was established in April 1949 pursuant to Section 11 of the Atomic Energy Act of 1946, and is the Board designated under Section 157a of the Atomic Energy Act of 1954. Section 157 provides that upon application for just compensation or awards or for the determination of a reasonable royalty fee certain proceedings shall be held before such a board.

CASPER W. OOMS, chairman; firm of Casper W. Ooms, Chicago, Ill.

ISAAC HARTER, of Babcock & Wilcox Tube Co., Beaver Falls, Pa.

JOHN V. L. HOGAN, consulting engineer, Hogan Laboratories, Inc., New York, N. Y.

COMMITTEE OF SENIOR REVIEWERS

The Committee of Senior Reviewers studies the major technical activities of the Atomic Energy Commission program and advises the Commission on classification and declassification matters, making recommendations with respect to the rules and guides for the control of scientific and technical information. The committee consists of six members appointed for a term of 5 years on a rotating basis.

Dr. WARREN C. JOHNSON, chairman; dean of physical sciences, University of Chicago, Chicago, Ill.

Dr. THOMAS B. DREW, head, department of chemical engineering, Columbia University, New York, N. Y.

Dr. ALVIN C. GRAVES, J division leader, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

Dr. JOHN P. HOWE, section chief, reactor materials, Atomics International, North American Aviation, Inc., Downey, Calif.

Dr. WINSTON M. MANNING, director, chemistry division, ANL, Lemont, Ill.

Dr. J. R. RICHARDSON, professor of physics, University of California, Los Angeles, Calif.

ADVISORY BODIES TO THE ATOMIC ENERGY COMMISSION

Advisory Committee on Biology and Medicine

The Advisory Committee on Biology and Medicine was created in September 1947, on the recommendation of the Commission's Medical Board of Review. The committee reviews the AEC programs in medical and biological research and health and recommends to the Commission general policies in these fields.

Dr. GIOACCHINO FAILLA, chairman; director, radiological research laboratory, College of Physicians and Surgeons, Columbia University, New York, N. Y.

Dr. JOHN C. BUGHER, director, medical education & public health, Rockefeller Foundation, New York, N. Y.

Dr. CHARLES H. BURNETT, professor of medicine, University of North Carolina, Chapel Hill, N. C.

Dr. SIMEON T. CANTRIL, director, Tumor Institute of Swedish Hospital, Seattle, Wash.

Dr. EDWARD A. DOISY, director, department of biochemistry, St. Louis University School of Medicine, St. Louis, Mo.

Dr. H. BENTLEY GLASS, professor of biology, The Johns Hopkins University, Baltimore, Md.

Dr. SHIELDS WARREN, vice chairman; pathologist, New England Deaconess Hospital, Boston, Mass.

Advisory Board of Contract Appeals

This board was established in February 1950. One or more of its members hears contract appeals arising under the "disputes articles" of AEC contracts and subcontracts and makes recommendations to the General Manager concerning their disposition.

HENRY P. BRANDIS, Jr., dean of the law school, University of North Carolina, Chapel Hill, N. C.

SHELDON D. ELLIOTT, director of institute for judicial administration, New York University, New York, N. Y.

ROBERT KINGSLEY, dean, school of law, University of Southern California, Los Angeles, Calif.

EDMUND R. PURVES, executive director, American Institute of Architects, Washington, D. C.

HERBERT F. TAGGART, dean, school of business administration, University of Michigan, Ann Arbor, Mich.

Advisory Committee on Industrial Information

The committee, formed in 1949, appraises technological developments within the national atomic energy program and makes recommendations which serve as guides in the formulation of AEC information-for-industry policy.

SIDNEY D. KIRKPATRICK, chairman; vice president and director of editorial development, McGraw-Hill Book Co., Inc., New York, N. Y.

Dr. ALLAN G. GRAY, editor, Steel, Penton Publishing Co., Cleveland, Ohio.

EUGENE HARDY, National Association of Manufacturers, Washington, D. C.

KEITH HENNEY, editor, Nucleonics and Electronics, McGraw-Hill Publishing Co., Inc., American Institute of Radio Engineers, New York, N. Y.

Dr. ELMER HUTCHISSON, editor, Journal of Applied Physics, American Institute of Physics, New York, N. Y.

NORMAN H. JACOBSON, Electric Light and Power, Haywood Publishing Co., Chicago, Ill.

WALTER E. JESSUP, editor, Civil Engineering, The American Society of Civil Engineers, New York, N. Y.

ANDREW W. KRAMER, editor, Power Engineering, The Technical Publishing Co., Chicago, Ill.

EVERETT S. LEE, American Institute of Electrical Engineers, New York, N. Y.

Dr. WALTER J. MURPHY, editor, Chemical and Engineering News, American Chemical Society, Washington, D. C.

FREDERICK A. PAWLEY, research secretary, American Institute of Architects, Washington, D. C.

EDWARD H. ROBIE, secretary, American Institute of Mining and Metallurgical Engineers, New York, N. Y.

KARL T. SCHWARTZWALDER, The American Ceramic Society, Inc., Columbus, Ohio.

GEORGE F. SULLIVAN, editor, The Iron Age, Chilton Publication, Inc., Philadelphia, Pa.

E. E. THUM, editor, Metal Progress, American Society for Metals, Cleveland, Ohio.

OLIVER H. TOWNSEND, secretary, Atomic Industrial Forum, Inc., New York, N. Y.

S. A. TUCKER, publications manager, American Society of Mechanical Engineers, New York, N. Y.

Dr. Alberto F. Thompson, head, office of scientific information, National Science Foundation, Washington, D. C.

F. J. Van Antwerpen, editor, Chemical Engineering Progress, American Institute of Chemical Engineers, New York, N. Y.

Bernard M. Fry, secretary; acting chief, technical information service, division of information services, AEC, Washington, D. C.

Advisory Committee on Isotope Distribution

This committee was originally appointed by the Manhattan District to advise on the off-project distribution of isotopes. The Commission approved its continuation in December 1947 to aid in establishing new policies on distributing radioactive materials and to review existing policies. The committee reviews all initial applications for use of radioisotopes in human beings, and all other requests for their use in research, education, and industry which are referred to it by the Commission.

Dr. John E. Christian, associate professor, department of pharmaceutical chemistry, Purdue University, Lafayette, Ind.

Dr. Leon O. Jacobson, associate dean, division of biological sciences, University of Chicago, Chicago, Ill.

Dr. Edith H. Quimby, associate professor of radiology, College of Physicians and Surgeons, Columbia University, New York, N. Y.

Dr. John E. Willard, professor of chemistry, University of Wisconsin, Madison, Wis.

Dr. Paul C. Aebersold, secretary; chief, isotopes division, AEC, Oak Ridge, Tenn.

Dr. Robert Robbins, department of radiology, Temple University Hospital, Philadelphia, Pa.

Advisory Committee on Reactor Safeguards

The committee, formed in 1953 from the former Reactor Safeguard Committee and the Industrial Committee on Reactor Location Problems, serves in an advisory capacity to the AEC with regard to the hazards associated with the operation of reactor facilities. The committee reviews safety studies prepared by organizations planning to build or operate reactor facilities and appraises proposed reactor locations in terms of accepted industrial safety standards.

Dr. C. Rogers McCullough, chairman; general development department, Monsanto Chemical Co., St. Louis, Mo.

Dr. Manson Benedict, professor of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Dr. Harvey Brooks, professor of physics, Harvard University, Cambridge, Mass.

Dr. Willard P. Conner, manager, physics division, research department, Hercules Powder Co., Wilmington, Del.

Dr. R. L. Doan, manager, atomic energy division, Phillips Petroleum Co., Idaho Falls, Idaho.

Dr. Hymer Friedell, director, department of radiology, Lakeside Hospital, Western Reserve University, Cleveland, Ohio.

Dr. I. B. Johns, Monsanto Chemical Co., Everett, Mass.

Dr. Mark M. Mills, radiation laboratory, University of California, Livermore, Calif.

K. R. OSBORN, manager of industrial development, general chemical division, Allied Chemical and Dye Corp., New York, N. Y.

D. A. ROGERS, manager, central engineering, Allied Chemical and Dye Corp., Morristown, N. J.

REUEL C. STRATTON, supervising chemical engineer, engineering and loss control division, the Travelers Insurance Co., of Hartford, Conn.

Dr. ABEL WOLMAN, head, department of sanitary engineering and water resources, The Johns Hopkins University, Baltimore, Md.

Dr. HARRY WEXLER, chief, scientific services division, U. S. Weather Bureau, Department of Commerce, Washington, D. C.

Dr. J. Z. HOLLAND, secretary; U. S. Atomic Energy Commission, Washington, D. C.

Advisory Committee on Stainless Steel

This committee, formed in 1950, by the Welding Research Council of the Engineering Foundation, in July 1951 at AEC request became advisory to the Commission in regard to research and development to improve the welding of type 347 stainless steel. All data resulting from these investigations are being made public. In October 1953 the scope of the committee's services was enlarged to include the manufacture, fabrication, and use of all stainless steels.

Dr. V. N. KRIVOBOK, chairman; development and research division, International Nickel Co., Inc., New York, N. Y.

W. O. BINDER, research laboratory, Union Carbide and Carbon Co., Niagara Falls, N. Y.

F. W. DAVIS, U. S. Atomic Energy Commission, Washington, D. C.

W. B. DELONG, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

R. B. GUNIA, Carnegie Illinois Steel Corp., Pittsburgh, Pa.

Dr. M. A. SCHEIL, director metallurgical research, A. O. Smith Corp., Milwaukee, Wis.

R. DAVID THOMAS, Jr., vice president and director, research and engineering, Arcos Corp., Philadelphia, Pa.

Advisory Committee of State Officials

This committee was established by the Commission in September 1955 as a means of obtaining the views and advice of State regulatory agencies in connection with AEC's regulatory activities in the field of public health and safety.

Dr. DANIEL BERGSMA, commissioner of health, Trenton, N. J.

A. C. BLACKMAN, chief, division of industrial safety, California Department of Industrial Relations, San Francisco, Calif.

Dr. ROY L. CLEERE, executive director, Colorado State Department of Public Health, Denver, Colo.

CURTISS M. EVERTS, Jr., director, division of sanitation and engineering, Oregon State Board of Health, Portland, Oreg.

JAMES G. FROST, deputy attorney general of Maine, Augusta, Maine.

Dr. ALBERT E. HEUSTIS, commissioner of health, Lansing, Mich.

WILLIAM T. LINTON, executive director, water pollution control authority, South Carolina State Board of Health, Columbia, S. C.

B. A. POOLE, director, bureau of environmental sanitation, State Board of Health, Indianapolis, Ind.

DONALD P. ROBERTS, chief, industrial hygiene section, Tennessee Department of Health, Nashville, Tenn.

CLARENCE I. STERLING, Jr., chief sanitary engineer, division of sanitation, Department of Public Health of the Commonwealth of Massachusetts, Boston, Mass.

Dr. IRVING TABERSHAW, director, division of industrial hygiene, New York State Department of Labor, New York, N. Y.

Dr. ARTHUR B. WELSH, medical coordinator for civil defense, Department of Health of Pennsylvania, Harrisburg, Pa.

Committee on Raw Materials

This committee was appointed in October 1947 to review the Atomic Energy Commission's raw materials program and to advise on questions of exploration, development, and procurement.

Chairmanship (vacant).

THOROLD F. FIELD, consulting mining engineer, Duluth, Minn.

FRANCIS C. FRARY, technical advisor, aluminum research laboratory, Aluminum Company of America, New Kensington, Pa.

J. K. GUSTAFSON, consulting geologist, M. A. Hanna Co., Cleveland, Ohio.

ERNEST H. ROSE, project director, metallurgy, Materials Advisory Board, National Research Council, Washington, D. C.

WALTER O. SNELLING, director of research and consulting chemist, Trojan Powder Co., Allentown, Pa.

ORVIL R. WHITAKER, consulting mining engineer, Denver, Colo.

Nuclear Cross Sections Advisory Group

This group is appointed on a yearly basis to make a continuing review of the AEC program of nuclear cross section measurements, and to evaluate the needs for cross section information in the various activities of the AEC. The following members were appointed to serve from July 1955 to July 1956.

Dr. RICHARD F. TASCHEK, chairman; physics division, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

Dr. LOWELL M. BOLLINGER, department of physics, Argonne National Laboratory, Lemont, Ill.

Prof. TOM W. BONNER, department of physics, Rice Institute, Houston, Tex.

Dr. JOSEPH L. FOWLER, physics division, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Dr. HERBERT GOLDSTEIN, Nuclear Development Corporation of America, White Plains, N. Y.

Prof. WILLIAM W. HAVENS, Jr., department of physics, Columbia University, New York, N. Y.

Dr. DONALD J. HUGHES, department of physics, Brookhaven National Laboratory, Upton, Long Island, N. Y.

Dr. GEORGE A. KOLSTAD, vice chairman; physics branch, division of research, AEC, Washington, D. C.

Prof. HENRY W. NEWSON, department of physics, Duke University, Durham, N. C.

Dr. JACK M. PETERSON, cyclotron group, University of California Radiation Laboratory, Livermore, Calif.

Dr. THOMA M. SNYDER, manager, nuclear physics section, Knolls Atomic Power Laboratory, Schenectady, N. Y.

Dr. IRA F. ZARTMAN, division of reactor development, U. S. Atomic Energy Commission, Washington, D. C.

Dr. CARROL W. ZABEL, secretary; department of physics, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

Patent Advisory Panel

This panel was appointed in January 1947. It makes informal reports and recommendations to the Commission and its staff on various questions of policy and procedure relating to patents and inventions.

H. THOMAS AUSTERN; of Covington & Burling, Washington, D. C.

WILLIAM H. DAVIS; of Davis, Hoxie & Faithfull, New York, N. Y.

JOHN A. DIENNER; of Brown, Jackson, Boettcher & Dienner, Chicago, Ill.

CASPER W. OOMS; firm of Casper W. Ooms, Chicago, Ill.

Personnel Security Review Board

This board was appointed in March 1949 primarily to review specific personnel security cases which arise under the Commission's administrative review procedure and to make recommendations concerning them to the General Manager. The board, in its monthly meetings, also advises the Commission on the broader considerations regarding personnel security, such as criteria for determining eligibility for security clearance and personnel security procedures.

GANSON PURCELL, chairman; of Purcell & Nelson, Washington, D. C.

Dr. PAUL E. KLOPSTEG, associate director, National Science Foundation, Washington, D. C.

WILLIAM E. LEAHY, president, Columbus University, Washington, D. C.

Stack Gas Problem Working Group

The appointment of this group was authorized in May 1948 to advise the Atomic Energy Commission and its contractors on problems in the treatment and control of gaseous effluents. The group meets formally at irregular intervals but renders continuing assistance in the field of air cleaning through specific research and development work directed by individual members and by individual consulting advice.

Dr. ABEL WOLMAN, chairman; head, department of sanitary engineering and water resources, The Johns Hopkins University, Baltimore, Md.

Dr. PHILIP DRINKER, professor of industrial hygiene, Harvard University School of Public Health, Boston, Mass.

Dr. LYLE I. GILBERTSON, director, research and engineering department, Air Reduction Co., Inc., Murray Hill, N. J.

Dr. H. FRASER JOHNSTONE, professor of chemical engineering, University of Illinois, Urbana, Ill.

Dr. CHARLES E. LAPPLE, Stanford Research Institute, Palo Alto, Calif.

Dr. WILLIAM P. YANT, director of research and development, Mine Safety Appliances Co., Pittsburgh, Pa.

APPENDIX 3

Major Research and Development Installations of the U. S. Atomic Energy Commission

Ames Laboratory (Iowa State College, contractor), Ames, Iowa

Director .... Dr. Frank H. Spedding
Associate Director .... Dr. H. A. Wilhelm
Assistant to Director .... Dr. Adolph F. Voigt

Argonne Cancer Research Hospital (University of Chicago, contractor), Chicago, Ill.

The participating institutions associated with Argonne National Laboratory (listed immediately below) are also affiliated with the Argonne Cancer Research Hospital.

Director .... Dr. Leon O. Jacobson
Associate Director .... Dr. Robert J. Hasterlik

Argonne National Laboratory (University of Chicago, contractor), Chicago, Ill.

The participating institutions are:

- Battelle Memorial Institute
- Carnegie Institute of Technology
- Case Institute of Technology
- Illinois Institute of Technology
- Indiana University
- Iowa State College
- Kansas State College
- Loyola University (Chicago, Ill.)
- Marquette University
- Mayo Foundation
- Michigan College of Mining and Technology
- Michigan State College
- Northwestern University
- Ohio State University
- Oklahoma Agricultural and Mechanical College
- Purdue University
- St. Louis University
- State University of Iowa
- Washington University (St. Louis, Mo.)
- Wayne University
- Western Reserve University
- University of Chicago
- University of Cincinnati
- University of Illinois
- University of Kansas
- University of Michigan
- University of Minnesota
- University of Missouri
- University of Nebraska
- University of Notre Dame
- University of Pittsburgh
- University of Wisconsin

Director .... Dr. Walter H. Zinn
Deputy Director .... Dr. Norman Hilberry
Business Manager .... John H. McKinley
Assistant Director, Technical Services .... John T. Bobbitt

Bettis Plant (Westinghouse Electric Corp., contractor), Pittsburgh, Pa.

Plant Manager, Westinghouse Electric Corp	JOHN W. SIMPSON
Manager, PWR Propect	JOSEPH C. RENGEL
Manager, SFR Project	ALEXANDER SQUIRE
Manager, LSR Project	JOHN T. STIEFEL
Manager, Naval Reactor Test Facility (Idaho)	ALFRED E. VOYSEY

Brookhaven National Laboratory (Associated Universities, Inc., contractor), Upton, Long Island, N. Y.

The participating institutions are:

- Columbia University
- Cornell University
- Harvard University
- Johns Hopkins University
- Massachusetts Institute of Technology
- Princeton University
- Yale University
- University of Pennsylvania
- University of Rochester

Chairman, Board of Trustees	Adm. EDWARD L. COCHRANE
President, AUI	LLOYD V. BERKNER
Vice President, AUI and Laboratory Director	Dr. LELAND J. HAWORTH
Deputy Laboratory Director	Dr. GERALD F. TAPE
Assistant Director	Dr. ROBERT A. PATTERSON
Assistant Director	WILLIAM H. FIELDS

Knolls Atomic Power Laboratory (General Electric Co., contractor), Schenectady, N. Y.

General Manager	K. R. VAN TASSEL
Manager, SIR Project	K. A. KASSELRING
Manager, SAR Project	F. E. CREVER
Manager, Technical Department	Dr. R. D. BENNETT
Manager, Auxiliary Operations Department	W. W. SMITH
Manager, Program and Commitments Study	F. B. HORNBY

Los Alamos Scientific Laboratory (University of California, contractor), Los Alamos, N. Mex.

Director	Dr. NORRIS E. BRADBURY
Technical Associate Director	Dr. DAROL K. FROMAN

Mound Laboratory (Monsanto Chemical Co., contractor), Miamisburg, Ohio

Project Director	Dr. N. N. T. SAMARAS
Laboratory Director	EDWARD C. MCCARTHY

Oak Ridge Institute of Nuclear Studies (contractor)
Oak Ridge, Tenn.

The sponsoring universities of the Institute are:

- Agricultural and Mechanical College of Texas
- Alabama Polytechnic Institute
- Catholic University of America
- Clemson Agricultural College
- Duke University
- Emory University
- Florida State University
- Georgia Institute of Technology
- Louisiana State University
- Meharry Medical College
- Mississippi State College
- North Carolina State College
- North Texas State College
- Rice Institute
- Southern Methodist University
- Tulane University of Louisiana
- Tuskegee Institute
- Vanderbilt University
- Virginia Polytechnic Institute
- University of Alabama
- University of Arkansas
- University of Florida
- University of Georgia
- University of Kentucky
- University of Louisville
- University of Maryland
- University of Mississippi
- University of North Carolina
- University of Oklahoma
- University of Puerto Rico
- University of South Carolina
- University of Tennessee
- University of Texas
- University of Virginia

Chairman of Council ---------- Dr. MARTEN TEN HOOR
Vice Chairman of Council ---------- Dr. W. M. NEILSEN
President of Institute ---------- Dr. PAUL M. GROSS
Vice President of Institute ---------- Dr. C. K. BECK
Scientific and Educational Consultant ---------- Dr. GEORGE B. PEGRAM
Executive Director of Institute ---------- Dr. WILLIAM G. POLLARD

Oak Ridge National Laboratory (Union Carbide Nuclear Co. of Union Carbide & Carbon Corp., contractor), Oak Ridge, Tenn.

Director ---------- Dr. A. M. WEINBERG
Deputy Director ---------- Dr. J. A. SWARTOUT
Assistant Laboratory Director ---------- Dr. G. E. BOYD
Assistant Laboratory Director ---------- Dr. R. A. CHARPIE
Assistant Laboratory Director ---------- Dr. E. D. SHIPLEY
Assistant Laboratory Director ---------- Dr. R. W. JOHNSON
Assistant Laboratory Director ---------- Dr. C. E. WINTERS

Radiation Laboratory (University of California, contractor), Berkeley, Calif.

Director ---------- Dr. ERNEST O. LAWRENCE
Associate Director ---------- Dr. LUIS W. ALVAREZ
Associate Director ---------- Dr. DONALD COOKSEY
Associate Director ---------- Dr. EDWIN M. MCMILLAN
Associate Director ---------- Dr. GLENN T. SEABORG
Associate Director ---------- Dr. EDWARD TELLER
Assistant Director ---------- WILLIAM M. BROBECK
Director, Crocker Laboratory Medical Physics ---------- Dr. JOSEPH G. HAMILTON
Director, Donner Laboratory of Medical Physics ---------- Dr. J. H. LAWRENCE
Director, Livermore Laboratory ---------- Dr. HERBERT F. YORK
Business Manager and Managing Engineer ---------- WALLACE B. REYNOLDS

Raw Materials Development Laboratory (National Lead Co., contractor), Winchester, Mass.

Technical Director and Manager — JOHN BREITENSTEIN

Rochester Atomic Energy Project (University of Rochester, contractor), Rochester, N. Y.

Director — DR. HENRY A. BLAIR
Business Manager — C. M. JARVIS

Sandia Laboratory (Sandia Corp., contractor), Sandia Base, Albuquerque, N. Mex.

President — JAMES W. MCRAE

University of California, Los Angeles, Atomic Energy Project (University of California, contractor), Los Angeles, Calif.

Director — DR. STAFFORD WARREN
Project Manager — ROBERT J. BUETTNER

University of California, Medical Center, Radiological Laboratory (University of California, contractor), San Francisco, Calif.

Director — DR. ROBERT S. STONE

National Reactor Testing Station, Idaho Falls, Idaho.

Nevada Test Site, Las Vegas, Nev.

Eniwetok Proving Grounds, Marshall Islands

APPENDIX 4

Isotope Distribution Data

Isotope	Number of Shipments [1]		
	Aug. 2, 1946 Dec. 31, 1955	Jan. 1, 1955 Nov. 30, 1955	Total to Nov. 30, 1955
Radioactive			
Iodine 131	23, 736	4, 583	28, 319
Phosphorus 32	14, 464	2, 306	16, 770
Carbon 14	1, 918	444	2, 362
Tritium	243	80	323
Strontium 89, 90	776	133	909
Cobalt 60	945	230	1, 175
Cesium 137	515	107	622
Iridium 192	131	52	183
Others	21, 474	3, 598	25, 072
Total	64, 202	11, 533	75, 735
Shipments to AEC installations	8, 248	1, 145	9, 393
Stable			
Deuterium Oxide	798	141	939
Deuterium	838	115	953
Boron 10, 11	267	62	329
Helium 3	41	22	63
Oxygen 18	344	53	397
Electromagnetically concentrated	986	218	1, 204
Argon 38	4		4
Total	3, 278	611	3, 889
Shipments to AEC installations	1, 843	232	2, 075

[1] Domestic shipments from Oak Ridge National Laboratory.

LOCATION AND TYPE OF NEW USERS

[Jan. 1, 1955–Nov. 30, 1955]

States and Territories	Medical Institutes and Physicians		Colleges and Universities		Industrial Firms		Federal and State Laboratories		Foundations and Institutions		Other		Total	
	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable
Alaska														
Alabama	1		1		3		1						6	
Arizona	4				1								5	
Arkansas	4				3								7	
California	28		1	3	27	4	2	1			2		60	8
Colorado	7				4								11	
Connecticut	3				9	1							12	1
Delaware	1												1	
District of Columbia	4												4	
Florida	6				1								7	
Georgia	3		1		3		1					1	8	1
Hawaii	1				1								2	
Idaho														
Illinois	17		1		17				1				36	
Indiana	6				6								12	
Iowa	2		1		2								5	
Kansas	3		2		2								7	
Kentucky	3		1		4								8	
Louisiana	4				5								9	
Maine	1				1								2	
Maryland	4	1			4		3	2			1		12	3
Massachusetts	12	1	1	1	14	2	4	1		1	1		32	6
Michigan	12				7		1	1					20	1
Minnesota	4		2										6	
Mississippi	2				3								5	
Missouri	6		1		3								10	
Montana	1												1	
Nebraska	6			1									6	1
Nevada	2												2	
New Hampshire														
New Jersey	10			1	18	2							28	3
New Mexico	2					1							2	1
New York	31	1		1	26	8	3			1	3		63	11
North Carolina	5				4		2				1		12	
North Dakota				1										1
Ohio	20				9	1				1			29	2
Oklahoma	5				3	1							8	1
Oregon	3												3	

LOCATION AND TYPE OF NEW USERS—Continued

[Jan. 1, 1955–Nov. 30, 1955]

States and Territories	Medical Institutes and Physicians		Colleges and Universities		Industrial Firms		Federal and State Laboratories		Foundations and Institutions		Other		Total	
	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable	Radio	Stable
Panama														
Pennsylvania	12	1		1	17	2							29	4
Puerto Rico	1		1										2	
Rhode Island					3								3	
South Carolina	1												1	
South Dakota	3												3	
Tennessee					2		1						3	
Texas	24			1	11		2		1		1		39	1
Utah	2				2								4	
Vermont			1	1									1	1
Virginia	2				3								5	
Washington	3				1		1						5	
West Virginia					4								4	
Wisconsin	9				9				1				19	
Wyoming	1								1		1		3	
Total	281	4	14	11	232	22	21	5	4	3	10	1	562	46

LOCATION AND TYPE OF USERS [Aug. 2, 1946–Nov. 30, 1955]

States and Territories	Medical Institutes and Physicians Radio	Medical Institutes and Physicians Stable	Colleges and Universities Radio	Colleges and Universities Stable	Industrial Firms Radio	Industrial Firms Stable	Federal and State Laboratories Radio	Federal and State Laboratories Stable	Foundations and Institutions Radio	Foundations and Institutions Stable	Other Radio	Other Stable	Total Radio	Total Stable
Alaska	1		1				1						3	
Alabama	10		3	1	14	1	4	1	2	1			33	4
Arizona	7		1	1	2		2						12	1
Arkansas	11		1	1	5		1						18	1
California	137	6	16	14	133	22	43	5	10	1	4		343	48
Colorado	28	1	3	2	11	1	4		2		2		50	4
Connecticut	14	1	5	3	44	4	2	1					65	9
Delaware	2		1	1	9	3	1		1	1			14	5
District of Columbia	14	4	3	4	6		17	7			1		41	15
Florida	22		6	2	4		4				1		37	2
Georgia	13		5	3	8		7					1	33	4
Hawaii	5		1		1		2		2				11	
Idaho	3		1		2						1		7	
Illinois	75	4	9	7	83	9	13	2	5	1	2		187	23
Indiana	20		3	4	29	4					1		53	8
Iowa	9	1	4	2	9								22	3
Kansas	15		4	2	5								24	2
Kentucky	9		3	1	12		2		1	1	2		29	2
Louisiana	16	1	5	3	14	2	3						38	6

Maine	5		3	1	13		1						22	1
Maryland	17	6	5	3	20	3	16	7			1		59	19
Massachusetts	41	8	16	12	86	13	11	3	3	2	3		160	38
Michigan	32	1	7	3	36	5	2	1			1		78	10
Minnesota	14	2	7	2	9		1						31	4
Mississippi	4		1	1	7	1	3	1					15	3
Missouri	38	2	5	4	13		1	1		1	1		58	8
Montana	7	2	1	1			1		1				10	3
Nebraska	12		3	1			3						18	1
Nevada	4				3		1						8	
New Hampshire	2		2	2	3		2						9	2
New Jersey	34		4	3	96	16	7	2	6	1	1	2	148	24
New Mexico	8		3	3	1	1	3						15	4
New York	164	13	27	21	150	23	22	2	8	3	6		377	62
North Carolina	16	1	6	3	12		7				1		42	4
North Dakota	6		2	1			1						9	1
Ohio	58	3	9	8	96	7	10	2	3	3	1		177	23
Oklahoma	16		1	1	23	7	1		3				44	8
Oregon	10	1	3	3	3		5				1		22	4
Panama	1						1						2	
Pennsylvania	63	9	11	8	115	15	11	3	4	2	1		205	37
Puerto Rico	5		1				2						8	
Rhode Island	4		2	1	11		1						18	1
South Carolina	4		3	2	2		2						11	2
South Dakota	6		2										8	
Tennessee	22	1	4	3	10	2	6	1			1		43	7
Texas	74	6	5	5	71	6	7		4	1	1	1	162	19
Utah	7	1	3	2	5		2						17	3
Vermont	3		1	1	2								6	1
Virginia	12	1	4	2	16	2	8						40	5
Washington	13		4	3	11	1	7						35	4
West Virginia	11		2	1	7	1	2						22	2
Wisconsin	22	1	3	3	40		4		1				70	4
Wyoming	2		1	1			1		1		1		6	1
TOTAL	1,151	76	226	156	1,252	149	258	38	57	17	27	4	2,975	442

SHIPMENTS OF RADIOACTIVE AND STABLE ISOTOPES TO FOREIGN COUNTRIES

Country	Jan. 1, 1955–Nov. 30, 1955		Total January 1947 to Nov. 30, 1955	
	Radio	Stable	Radio	Stable
Argentina	1	0	125	0
Australia	2	2	110	2
Austria	0	0	1	0
Belgian Congo	1	0	3	0
Belgium	15	0	160	2
Bermuda	0	0	16	0
Bolivia [1]	0	0	0	0
Brazil	100	0	359	0
British West Africa	0	0	1	0
Canada	208	9	882	15
Chile	25	0	124	0
China	1	0	1	0
Colombia	8	0	16	0
Costa Rica	1	0	1	0
Cuba	102	0	337	0
Denmark	4	0	227	1
Dominican Republic	0	0	1	0
Egypt	0	0	2	0
El Salvador [1]	0	0	0	0
England	16	4	161	5
Finland	0	0	14	0
France	12	16	123	24
Germany	11	10	35	9
Gold Coast	0	0	1	0
Greece	0	0	1	0
Guatemala	12	0	24	0
Honduras	1	0	1	0
Iceland	0	0	5	0
India	7	2	29	2
Indonesia	0	0	3	0
Ireland [1]	0	0	0	0
Israel	3	0	9	0
Italy	5	0	39	1
Japan	58	1	388	1
Korea [1]	0	0	0	0
Lebanon	0	0	6	0
Mexico	41	0	137	0
Netherlands	14	2	71	3
New Zealand	0	0	12	0
Nicaragua [1]	0	0	0	0
Norway	1	2	44	2
Pakistan	0	0	7	0
Paraguay [1]	0	0	0	0
Peru	14	0	34	0
Philippines	4	0	6	0
Portugal	3	0	8	0
Spain	1	0	10	0
Sweden	15	1	207	1
Switzerland	9	0	72	1
Syria [1]	0	0	0	0
Thailand	1	0	1	0
Trieste	0	0	3	0
Turkey	0	0	5	0
Union of South Africa	2	3	31	4
Uruguay	1	0	11	0
Venezuela	20	0	28	0
Yugoslavia	0	0	1	0
Total	719	52	3,893	73

[1] Authorized to receive isotopes; no shipments made.

Kind of Isotope	Jan. 1, 1955–Nov. 30, 1955	Total January 1947 to Nov. 30, 1955
Radioactive Isotopes:		
Phosphorus 32	76	936
Iodine 131	302	1,266
Carbon 14	45	348
Sulfur 35	7	127
Iron 55, 59	28	139
Cobalt 60	30	212
Strontium 89, 90	28	106
Calcium 45	20	118
Other	183	641
Total	719	3,893
Stable Isotopes:		
Argon 38	2	2
Deuterium Gas	4	4
Deuterium Oxide	2	3
Boron	13	23
Electromagnetically concentrated	27	34
Helium 3	4	4
Rare Earths	0	3
Total	52	73
Total Foreign Isotope Shipments	771	3,966

369460—56——10

APPENDIX 5

AEC-Owned Patents

PATENTS ISSUED TO THE COMMISSION WHICH ARE AVAILABLE FOR LICENSING [1]

The following 133 U. S. Letters Patents owned by the United States Government as represented by the Atomic Energy Commission are in addition to the 66 patents listed in the 17th Semiannual report. The patents listed have been made available for licensing at periodic intervals. Licenses are granted on a non-exclusive royalty-free basis.

Patent No.	Title	Patentee
2,693,700	Pressure Ascertaining Means	C. V. Osborne, Albuquerque, N. Mex.
2,693,705	Liquid Sampler	J. A. Casler, Royal Oak, H. O. Smith, L. F. Coleman, and M. Levenson, Chicago, Ill.
2,694,146	Pulse Analyzer	R. Fairstein, Oak Ridge, Tenn.
2,695,213	Recovery of Zirconium Tetrachloride from Its Complex Compounds.	W. C. Fernelius, State College, Pa.
2,695,214	Method Making Metallic Oxyfluorides	D. W. Sherwood, Leonia, N. J., G. C. Banikiotes, Brooklyn, N. Y.
2,695,268	Process for the Concentration of Isotopes	C. A. H. Wright, Tadanac, British Columbia, Canada.
2,695,364	Pyrometer	R. A. Wolfe, Ann Arbor, Mich.
2,695,715	Remote Control Manipulator	R. C. Goertz, Downers Grove, Ill., R. G. Schmitt, Naperville, Ill.
2,696,050	Atomic Bomb Air Zero Locator	B. C. Taylor, Battle Creek, Mich.
2,696,530	Electrostatic Amplifier	Q. A. Kerns, Berkeley, Calif.
2,696,539	Dual Circuit Electrical Safety Device	E. W. Peterson, Kansas City, Mo.
2,696,564	Radio Electric Generator	P. E. Ohmart, Dayton, Ohio.
2,697,518	*Flotation Methods for Uranium Ores*	G. A. Bennett, Patchogue, N. Y., P. L. Veltman, Severna Park, Md.
2,697,529	Apparatus for Handling Frangible Articles by Remote Control.	J. P. Hubbell, Garden City, Long Island, N. Y., H. J. Reinig, West Englewood, N. J.
2,697,788	Ion Sources	R. R. Wilson, Ithaca, N. Y.
2,698,290	The Isotope of Curium Having a Mass Number of 238.	G. T. Seaborg and Kenneth Street, Jr., Berkeley, Calif.
2,698,905	Magnetic Time-of-Flight Mass Spectrometer	S. A. Goudsmit, Sayville, N. Y.
2,700,107	Ion Source	J. S. Luce, Oak Ridge, Tenn.
2,700,149	Polarity Selector	J. J. Stone, Jr., Clinton, Tenn.
2,700,606	Production of Vanadium Metal	H. A. Wilhelm and J. R. Long, Ames, Iowa.
2,700,736	Method and Apparatus for Measuring Radiation Quantities.	N. O. Roberts, Liverpool, England.
2,702,523	Apparatus for Vapor Coating Base Material in Powder Form.	R. J. Prestwood, St. Louis, Mo., D. S. Martin, Ames, Iowa.
2,703,271	Recovery of Uranium from Aqueous Solutions.	J. F. Shea, Columbus, Ohio, M. G. Willigman, Elgin, Ill.
2,703,337	Insulator Clamping Device	W. L. Scott, Jr., Oak Ridge, Tenn.
2,703,843	Mass Spectrometry	A. E. Cameron, Oak Ridge, Tenn.
2,704,330	Voltage Stabilized Oscillator	T. F. Marker, Sandia Base, Albuquerque, N. Mex.
2,704,335	Ion Producing Mechanism	J. S. Luce, Oak Ridge, Tenn.
2,705,108	Electronic Adder-Accumulator	J. J. Stone, Jr., Clinton, Tenn.
2,705,674	Ternary Zirconium Alloys	W. Chubb, Columbus, Ohio.
2,706,676	The Conversion of Fluorine to Hydrogen Fluoride by Superheated Steam.	C. R. Schmitt and S. H. Smiley, Oak Ridge, Tenn.
2,707,555	Beryl Ore Selector	A. M. Gaudin, Newtonville, Mass.
2,707,964	Measurement and Control of the Compositions of Flowing Streams of Fluid Mixtures.	P. S. Monroe, Summit, N. J.
2,708,148	Camera Timer	M. R. Clark, Detroit, Mich.
2,708,656	Neutronic Reactor	E. Fermi (deceased), L. Szilard, Waltham, Mass.
2,709,222	Methods of and Apparatus for Separating Materials.	E. O. Lawrence, Berkeley, Calif.
2,709,750	Magnetic-Period Mass Spectrometer	L. G. Smith, Center Moriches, N. Y.
2,709,791	Saturable Reactor	R. L. Anderson, Jr., El Cerrito, Calif.
2,710,249	*Iodine-132 Generator & Shipping Container*	W. E. Winsche, Wilmington, Del., L. G. Stang, Jr. and G. J. Selvin, E. Patchogue, N. Y., and W. D. Tucker, Sayville, N. Y.

[1] Patents listed as of November 29, 1955. Applicants for licenses should apply to Chief, Patent Branch, Office of the General Counsel, U. S. AEC, Washington 25, D. C., identifying the subject matter by patent number and title.

Patents Issued to the Commission Which are Available for Licensing—Continued

Patent No.	Title	Patentee
2,710,354	Ion Source	M. G. Inghram, Chicago and D. C. Hess, Riverdale, Ill.
2,710,538	Electromagnetic Pressure Gage	L. B. Vandenberg, Sharon Springs, N. Y.
2,711,362	Curium-Americium Separation and Purification Process.	Kenneth Street, Jr., Berkeley, Calif.
2,711,364	Polishing Metals and Composition Therefor.	J. G. Beach, Columbus, Ohio.
2,711,389	Method of Applying Adherent Electroplates to Zirconium Surfaces.	J. G. Beach, W. C. Schickner, and C. L. Faust, Columbus, Ohio.
2,711,972	Production of Corrosion Resistant Coatings on Metal Structures.	W. T. Miller, Ithaca, and A. D. Kirshenbaum, New York, N. Y.
2,712,073	Temperature Control	E. V. Martin, Oak Ridge, Tenn.
2,712,074	Electrical Control Circuit	H. G. Neil, Oak Ridge, Tenn.
2,712,075	Automatic Emission Control Circuit	M. Bevis, Oak Ridge, Tenn.
2,712,078	Electric Discharge Device	W. R. Baker, Berkeley, Calif.
2,712,079	Calutron	L. P. Hunter, Oak Ridge, Tenn.
2,712,114	Marker Pulse Generator	W. R. Aiken, Berkeley, Calif.
2,712,636	Short Circuit Eliminator	J. W. Litton, and R. F. Krueger, Oak Ridge, Tenn.
2,713,093	Switch Mechanism	W. A. Joerndt and J. J. Kane, Albuquerque, N. Mex.
2,713,097	Accelerometer	A. D. Wooten, Falls Church, Va.
2,713,554	Electrolytic Method of Recovering Thorium from Monazite Sand.	E. C. Pitzer, Schenectady, N. Y.
2,713,640	Electron Control Apparatus	H. W. Savage, Oak Ridge, Tenn.
2,713,641	Calutron Structure	B. T. Wright and E. O. Lawrence, Berkeley, Calif.
2,713,677	Method and Apparatus for Discriminating Frequency Modulated Records.	J. H. Scott and J. W. Valentine, Albuquerque, N. Mex., and W. Gross, San Diego, Calif.
2,714,164	Mass Spectrometer Sampling System	J. W. Riggle, New Castle, and J. B. Roberts, Wilmington, Del.
2,714,165	Isotope Separating Apparatus	J. D. Reid, Oak Ridge, Tenn.
2,714,166	Calutron Structure	C. Starr, Pacific Palisades, Calif.
2,714,170	Neutron Selector	I. Bloch, Chicago, Ill.
2,714,554	Method of Producing Gadolinium	F. H. Spedding and A. H. Daane, Ames, Iowa.
2,714,555	Method of Separating Certain Platinum Group Metals with Cation Exchange Resins	P. C. Stevenson, Livermore, A. A. Franke, San Francisco, R. J. Borg, Millbrae, and W. E. Nervik, PiedmontCalif.
2,714,577	Neutronic Reactor	E. Fermi (deceased). W. H. Zinn, Chicago Ill.
2,714,664	Calutrons	E. O. Lawrence, Berkeley, Calif.
2,714,665	Isotope Separating Apparatus	W. C. Tunnell, Oak Ridge, Tenn.
2,714,666	Regulator for Calutron Ion Source	B. F. Miller, Berkeley, Calif.
2,714,667	Calutron Operation	J. H. Burney, Corpus Christi, Tex., W. H. Appleton, Lafayette, Calif., and R. de Liban and G. M. Farley, Berkeley, Calif.
2,714,668	Radiation Responsive Device	W. H. Zinn, Chicago, Ill.
2,714,677	Compensated Ion Chamber	S. M. MacNeille, Fairport, N. Y.
2,715,181	Pulse Height Analyzer	W. E. Glenn, Jr., Schenectady, N. Y., Almon E. Larsh, Jr., Berkeley, Calif.
2,715,185	Automatic Control System	C. W. Roeschke, Albuquerque, N. Mex.
2,715,186	Isotope Separating Apparatus	H. L. Hull and S. M. MacNeille, Oak Ridge, Tenn.
2,715,196	Electron Emitter	J. D. Reid, Oak Ridge, Tenn.
2,715,359	Laboratory Hood	A. D. Mackintosh and T. W. Hungerford, Oak Ridge, Tenn.
2,715,682	Ion Source for Calutrons	E. O. Lawrence, Berkeley, Calif.
2,715,683	Ion Source for a Calutron	J. G. Backus and B. Peters, Berkeley, Calif.
2,715,692	Ion Producing Apparatus	A. B. Cardwell, Manhattan, Kans.
2,715,693	Deep Collimating Slot	S. M. MacNeille, Oak Ridge, Tenn., K. R. MacKenzie, Vancouver, British Columbia, Canada.
2,715,694	Ion Producing Apparatus	H. P. Yockey, Inglewood, Calif.
2,715,695	Ion Producing Mechanism	J. A. DeJuren, Berkeley, Calif.
2,716,051	Method of Producing Zirconium Halide	I. E. Campbell, Gahanna, Ohio.
2,716,075	Polyethylene Coating and Method of Applying the Same	R. A. Wiese, New York, N. Y.
2,716,168	Electrical Switch	F. R. Shonka, Riverside, Ill.
2,716,194	Pulse Generator	D. A. Mack, Berkeley, Calif.
2,716,197	Ion Source	R. J. Jones and R. E. Wright, Oak Ridge, Tenn.
2,716,211	Thyratron Trigger Circuit for Discharging a Capacitor	E. A. Aas, Albuquerque, N. Mex.
2,716,229	Leak Detector	R. F. Wehrmann, Dayton, Ohio, and E. W. Rebol, Richland, Wash.
2,716,523	Device for Counting Alpha and Beta Particles	G. E. Driver, Richland, Wash.
2,716,530	Support for a Tube Cutting Device	P. E. Lowe and H. J. Bellarts, Richland, Wash.
2,716,705	Radiation Shield	W. H. Zinn, Chicago, Ill.
2,716,943	Liquid Metal High Pressure	L. B. Vandenberg, Sharon Springs N. Y.
2,717,234	Method of Preparing K_2UF_6 for Fused Bath Electrolysis	R. Nagy, Bloomfield, and J. W. Marden. East Orange, N. J.

Patents Issued to the Commission Which are Available for Licensing—Continued

Patent No.	Title	Patentee
2,717,316	Pulse Limiter and Shaper	R. Madey, Berkeley, Calif.
2,717,353	Precision Regulated Power Supply	C. Sewell, Jr., Los Alamos, and D. M. Button, Mesilla Park, N. Mex.
2,717,696	Separation of Fission Products by Adsorption from Organic Solvents..	J. Schubert, Chicago, Ill.
2,717,915	Apparatus for Production of Purified Metals	Z. M. Shapiro, Pittsburgh, Pa.
2,717,962	Electric Discharge Devices	L. F. Wouters, Berkeley, Calif.
2,717,963	Arc Discharge Device	W. M. Brubaker, Crescent Hills, Pa.
2,717,964	Sulfur Crystal Counter	V. L. Parsegian, Brooklyn, N. Y., R. C. Maninger, Montvale, N. J.
2,718,235	Valve Device for Isotope Separating Apparatus	P. J. Galbreath and W. C. Tunnell, Oak Ridge, Tenn.
2,718,459	Remote Control Apparatus for Transferring Liquids	M. C. Leverett, Houston, Tex., F. R. Ward, Springfield, Mass., and J. T. Weills, Long Island City, N. Y.
2,719,233	Charge Receptacles for Use in Ion Source Units	D. C. Sewell, Berkeley, Calif.
2,719,777	Process and Apparatus for Protecting Uranium Hexachloride from Deterioration and Contamination	D. Lipkin, Santa Fe, N. Mex., S. E. Weissman, Chicago, Ill.
2,719,823	Neutronic Reactor Radiation Indicator	W. H. Zinn, Chicago, Ill.
2,719,843	Method of Synthesizing Nucleosides and Analogous Compounds and Compounds Prepared Thereby	J. Davoll, London, England, G. B. Brown, Mamaroneck, N. Y.
2,719,924	Magnetic Shims	J. R. Oppenheimer, Princeton, N. J., S. P. Frankel, Los Angeles, Calif., and E. C. Nelson, Los Alamos, N. Mex.
2,719,925	Electric Discharge Device	F. Oppenheimer, Berkeley, Calif.
2,719,941	Reciprocating Motor Control for Automatic Cut-Off Apparatus	C. S. Presenz, Berkeley, Calif.
2,720,105	Radiation Shield Block	J. O. Billups, Manhattan Beach, Calif.
2,720,593	Scintillation-Type Ion Detector	P. I. Richards, Bellport, and E. E. Hays, Eastport, N. Y.
2,720,622	Regulated Low Voltage Power Supply	W. H. Deuser, El Cerrito, Calif.
2,721,272	Calutrons	E. O. Lawrence, Berkeley, Calif.
2,721,699	Beam Current Integrator	W. R. Baker, Berkeley, Calif.
2,721,700	do	R. DeLiban and W. R. Baker, Berkeley, Calif.
2,722,609	Radiation Analysis	G. W. Morgan, O. M. Bizzell, Oak Ridge, J. W. Hitch, Maryville, Tenn., and G. G. Manov, Washington, D. C.
2,723,181	Processes of Producing Uranium Trioxide	C. E. Larson, Oak Ridge, Tenn.
2,723,371	Arc Safety Device for High Voltage Power Supply.	R. P. Featherstone, Minneapolis, Minn.
2,723,901	Cation Exchange Separation Process	F. T. Hagemann, Chicago, Ill., H. C. Andrews, Ames, Iowa.
2,724,058	Calutron Receivers	S. P. Frankel, Los Angeles, Calif.
2,725,028	Combined Adjusting and Indicating Means	H. H. Obergfell, Albuquerque, N. Mex.
2,725,278	Manufacture of Uranium Tetrachloride	M. J. Polissar, San Francisco, Calif.
2,725,279	Preparation of Uranium Hexachloride	R. E. Van Dyke and E. C. Evers, Providence, R. I.
2,725,284	Apparatus for Reacting Dense Chlorinating Vapor with a Solid.	M. J. Polissar, San Francisco, Calif.
2,725,477	Calutron Receivers	J. G. Backus, Berkeley, Calif.
2,725,478	Apparatus for the Separation of Materials	B. T. Wright, Santa Fe, N. Mex.
2,725,479	Calutron Receivers	W. E. Parkins, Berkeley, Calif.
2,725,480	Calutron Shielding	J. R. Richardson, Berkeley, Calif.
2,725,481	Calutron Receiver	S. W. Barnes, Rochester, N. Y.

APPENDIX 6

REGULATIONS OF THE U. S. ATOMIC ENERGY COMMISSION [1]

PART 7—ADVISORY BOARDS

Notice is hereby given that the Atomic Energy Commission has adopted the following part:

AUTHORITY: §§ 7.1 to 7.10 issued under sec. 161, 68 Stat. 948; 42 U. S. C. 2201.

§ 7.1 *Purpose.* The regulations in this part set forth the scope, procedure and limitations of the authority of advisory boards established by the Atomic Energy Commission pursuant to section 161a of the Atomic Energy Act of 1954 (68 Stat. 919).

§ 7.2 *Definitions.* As used in this part:

(a) "Commission" means the Atomic Energy Commission.

(b) "Duly authorized representative" of the Commission means a full-time government employee designated by the Commission or the General Manager.

§ 7.3 *Functions and limitations.* (a) It is the function of an advisory board to furnish advice, recommendations and opinions concerning the subject matter with respect to which the board has been established. Advisory boards may not establish policy or take any action on behalf of the Commission.

(b) Advisory boards may not request information from any source other than the Commission either in the name of the board or in the name of the Commission. Information needed by an Advisory Board will be obtained by the Commission or its duly authorized representative.

§ 7.4 *Chairman.* (a) Each advisory board will have as chairman a full-time government employee, except where the Commission finds that the public interest will not be adversely affected if the chairman is not a full-time government employee.

(b) The chairman will preside at all meetings of the advisory board and will be responsible for the control and conduct of its meetings. Where the Commission makes an exception to the requirement of a full-time government chairman, a full-time government employee will attend all meetings of the advisory board.

§ 7.5 *Membership.* The Commission or its duly authorized representative will appoint the members of the advisory boards.

§ 7.6 *Meetings.* (a) Advisory boards shall meet only at the call of the Commission or its duly authorized representative. Meetings will be called sufficiently in advance to enable board members to make arrangements to attend and to permit prior individual consideration of the matters to be discussed.

(b) Except as otherwise authorized by the Commission or its duly authorized representative, advisory boards

[1] Policies and regulations of the U. S. AEC announced prior to December 1955 can be found in the Federal Register and in the following semiannual reports: Fifth Report, Sixth Report, Ninth Report, Tenth Report, Eleventh Report, Twelfth Report, Thirteenth Report, Fourteenth Report, Fifteenth Report, Sixteenth and Seventeenth Reports.

shall meet only on government premises.

§ 7.7 *Agenda.* The agenda for each meeting will be formulated by the Commission or its duly authorized representative and, so far as practicable, will be forwarded to the members of the advisory board in advance of the meeting.

§ 7.8 *Minutes.* (a) Full and complete minutes of each meeting shall be kept, including a record of those in attendance. Such minutes shall be maintained as permanent and official records of the Commission.

(b) The chairman or the duly authorized representative of the Commission shall decide whether a stenographic transcript is necessary.

§ 7.9 *Subcommittees.* All advisory board subcommittees, temporary or permanent, shall be subject to the rules and procedures governing the respective full boards.

§ 7.10 *Industry advisory committees and conferences.* (a) Industry advisory committees and industry advisory conferences are deemed to be industry advisory boards and subject to the requirements of the regulations in this part. Except as otherwise authorized by the Commission, or its duly authorized representative, attendance at meetings of industry advisory committees or conferences shall be limited to the members of the committee or conference and Commission employees.

(b) Persons selected for membership on industry advisory committees or conferences shall be chosen, insofar as is practicable, with a view to assure a representation of a cross-section of the group or groups affected, with due consideration given to large, medium and small business, geographic distribution, members and non-members of trade associations and other relevant factors.

Dated at Washington, D. C., this 25th day of August 1955.

K. E. Fields,
General Manager.

Part 37—Radioisotope Research Support Program

Discount Purchase Procedures

Pursuant to the Atomic Energy Act of 1954 (Public Law 703, 83d Cong., 2d Sess.; 68 Stat. 919ff) and the Administrative Procedure Act of 1946, as amended (Public Law 404, 79th Cong., 2d Sess.), amendments to Title 10, Part 37, Code of Federal Regulations, entitled "Radioisotope Research Support Program", effective July 1, 1955, and published in Volume 20 page 4712 et seq. of the Federal Register, are set forth hereunder to be effective upon publication.

1. Amend § 37.12 to read as follows:

§ 37.12 *Discount purchase procedures.* Discount Certificate holders may make discount purchases of radioisotopes from either suppliers or distributors:

(a) By providing the supplier or distributor with a purchase order upon which, or affixed to which, is an exact signed copy of the following:

The undersigned certifies to the supplier and to the U. S. Atomic Energy Commission that Discount Certificate No. ______, which expires ____________, has been issued to the undersigned by the Director, Division of Biology and Medicine, U. S. Atomic Energy Commission, authorizing the purchase of radioisotopes at 20% of AEC established price; that isotopes purchased under this authority will be used only for agricultural and biomedical research, including research in medical therapy and diagnosis; that the undersigned is authorized, pursuant to the regulations in Title 10, Part 30, Code of Federal Regulations, Radioisotope Distribution, to procure such radioisotopes; and, that all of the information set forth and the statements made herein are to the best of (its) (my) knowledge true and correct.

____
(Signature)

(b) By forwarding to the supplier or distributor, along with the first purchase order placed with it during the fiscal year then current, a copy of the purchaser's Discount Certificate as furnished by the Commission, or a certified true copy thereof.

2. Insert the following note as a separate paragraph after § 37.13 (d):

NOTE: The reporting requirements contained herein have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

(Sec. 161, 68 Stat. 948; 42 U. S. C. 2201)

Dated at Washington, D. C., this 30th day of August 1955.

K. E. FIELDS,
General Manager.

AUTHORIZATION FOR CERTAIN ACTIVITIES UNDER SECTION 57a (3) (B) OF THE ATOMIC ENERGY ACT OF 1954

1. Notice is hereby given that, pursuant to Section 57a.(3)(B) of the Atomic Energy Act of 1954 (68 Stat. 932), the Atomic Energy Commission has determined that any activity which:

(a) Constitutes directly or indirectly engaging in the production of any special nuclear material in any foreign country other than countries or areas now or hereafter listed as Subgroup A countries or destinations in Section 371.3 of the Comprehensive Export Schedule of the United States Department of Commerce; and

(b) Does not involve the communication of Restricted Data or other classified defense information; and

(c) Is not in violation of other provisions of law; will not be inimical to the interest of the United States and is authorized by the Atomic Energy Commission.

Nothing in the foregoing determination or authorization shall relieve any person from compliance with other provisions of law or regulation, including rules, regulations or orders relating to the export of production or utilization facilities, or source, special nuclear, or byproduct materials, pursuant to the Atomic Energy Act of 1954 or relating to the export of commodities or technical data pursuant to the Export Control Act of 1949, as amended, the Mutual Security Act of 1954, or other law.

2. The Commission intends soon to promulgate regulations incorporating the foregoing determination and authorization. It is planned that such regulations will include provisions requiring persons who have engaged in certain activities pursuant to the authorization set forth in paragraph 1 of this Notice to submit a report to the Commission concerning such activity.

3. Inquiries concerning this Notice may be addressed to the Atomic Energy Commission, Washington 25, D. C., Attention: Director, Division of Civilian Application.

Dated at Washington, D. C., this 30th day of September 1955.

K. E. FIELDS,
General Manager.

APPENDIX 7

Current AEC Unclassified Research Contracts in Physical and Biological Sciences, Raw Materials, and Reactor Development [1]

PHYSICAL RESEARCH CONTRACTS

Chemistry

Alabama, University of. J. L. Kassner, and E. L. Grove, A Study of the Principles, Theory and Practice of High Frequency Titrimetry.

Arizona, University of. S. Chapin, The Mechanism of the Heterogeneous Low Temperature Ortho Hydrogen Conversion.

Arkansas, University of. R. R. Edwards, Chemical Effects of Nuclear Transformation.

Arkansas, University of. R. R. Edwards, Investigation of the Radioactivity of Thermal Waters and Its Relationship to the Geology and Geochemistry of Uranium.

Brooklyn, Polytechnic Institute of. R. B. Mesrobian and H. Morawetz, Study of Radiation Induced Solid State Polymerization.

Buffalo, University of. G. M. Harris, Applications of Isotopes in Chemical Kinetics.

California Institute of Technology. H. Brown, Study of Fundamental Geochemistry of Critical Materials & Development of Economic Processes for Their Isolation.

California Institute of Technology. N. Davidson, Complex Ions and Reaction Mechanisms in Solution.

California, University of. C. S. Garner, Isotope Exchange Reactions.

California, University of. J. H. Hildebrand, Studies in Intermolecular Forces and Solubility.

California, University of. R. L. Scott, Fluorocarbon Solutions.

Carnegie Institute of Technology. T. P. Kohman, Nuclear Chemistry Research.

Catholic University of America. F. O. Rice, The Thermal Production and Identification of Free Radicals.

Chicago, University of. C. A. Hutchison, Paramagnetic Resonance Absorption.

Chicago, University of. N. Sugarman and A. Turkevich, Operation of Synchrocyclotron.

Chicago, University of. N. Sugarman and A. Turkevich, Nuclear Chemical Research.

Chicago, University of. H. C. Urey, Natural Abundance of Deuterium and Other Isotopes.

Clark University. A. E. Martell, Reactions of Partially-Chelated Metal Ions.

Clarkson College of Technology. M. Kerker, A Study of the Size and Shape of Colloidal Particles by Light Scattering and Electron Microscopy.

Clarkson College of Technology. H. L. Shulman, The Determination of Interfacial Area in Packed Absorption and Distillation Columns.

Colorado, University of. R. N. Keller, The Scintillation Properties of Coordination Compounds.

Columbia University. J. L. Kulp, Helium in the Atmosphere and Lithosphere.

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[1] Contracts listed as of November 30, 1955.

Columbia University. J. L. Kulp, U-Pb Method of Age Determination.
Columbia University. V. K. LaMer, Fundamental Investigation of Phosphate Slimes.
Columbia University. J. M. Miller, Research in the Field of Radiochemistry.
Columbia University. R. M. Noyes, Photochemical Reactions of Iodine.
Columbia University. T. I. Taylor, Separation of Isotopes by Chemical Exchange.
Connecticut, University of. R. Ward, Tracer Element Distribution between Melt and Solid.
Cornell University. R. Bersohn, Gradient of the Electric Field in Ionic Crystals.
Cornell University. F. A. Long, Kinetic and Equilibrium Salt Effects.
Delaware, University of. R. L. Pigford, Thermal Diffusion in Liquids.
Duke University. H. A. Strobel, Ion Exchange in Polar Non-Aqueous Solvents.
Florida State University. R. E. Johnson, Exchange Between Labeled Halogens and Certain Inorganic Halides.
Florida State University. R. H. Johnsen, Radiation Induced Effects in Heterogeneous Organic Systems.
Florida State University. R. Sheline, Search for Long-Lived Radioactivities; Theoretical Nuclear Studies.
Florida, University of. G. B. Butler and A. H. Gropp, Studies in the Preparation and Properties of Quaternary Ammonium Ion Exchange Resins.
Fordham University. M. Cefola, Studies of Formation of Complexes by Thenoyltrifluoroacetate and Other Chelating Agents.
Harvard University. E. S. Barghoorn, Radioactivity in Uraniferous Plant Fossils.
Harvard University. R. M. Diamond and G. Wilkinson, Nuclear and Inorganic Chemistry of the Transitional Elements.
Harvard University. C. Frondel, Synthesis of Uranium and Thorium Minerals.
Howard College. J. A. Southern, Cyclotron Research.
Illinois Institute of Technology. M. L. Bender, Correlation of Isotopic Effect on Reaction Rate with Reaction Mechanism.
Illinois Institute of Technology. G. Gibson, Fundamental Chemistry of Uranium.
Illinois Institute of Technology. H. E. Gunning, Decomposition of Organic Molecules by Metal-Photosensitization.
Illinois, University of. H. G. Drickamer, The Mechanism of Molecular Motion as Determined from Diffusion and Thermal Diffusion Measurements.
Illinois, University of. P. E. Yankwich, Studies in Radiochemistry.
Indiana University. L. L. Merritt, Study with Radioactive Tracers.
Indiana University. W. J. Moore, Rate Processes in Inorganic Solids at High Temperatures.
Indiana University. W. B. Schaap and F. C. Schmidt, Electrochemical Research in Amine Solvents.
Iowa, State University of. L. Eyring, Preparation of Rare Earth Oxides.
Iowa, State University of. K. Kammermeyer, Separation of Gases by Diffusion Through Permeable Membranes.
Johns Hopkins University. W. S. Koski, Nuclear Chemistry Studies.
Kansas State College. R. E. Hein, Labeled Chemical Species Produced by Neutron Irradiation of Phosphorous Trichloride and Related Compounds.
Kansas State College. E. R. Lippincott, Raman Spectra of Colored and Absorbing Substances.
Kansas, University of. P. W. Gilles, High Temperature Research.
Kansas, University of. P. W. Gilles, Hot Laboratory Assistance.
Kansas, University of. J. Kleinberg and E. Griswold, Some Problems in the Chemistry of Low Oxidation States of Metals.

Little, Inc., Arthur D. G. A. Bleyle, Study of Deuterium Separation.

Louisville, University of. R. H. Wiley, The Synthesis and Properties of Ion Exchange Resins.

Massachusetts Institute of Technology. M. Benedict, Transfer of Deuterium from Steam to Hydrogen.

Massachusetts Institute of Technology. A. M. Gaudin, Techniques in Mineral Engineering.

Massachusetts Institute of Technology. P. M. Hurley, Investigations of Isotopic Abundances of Strontium, Calcium and Argon in Certain Minerals.

Massachusetts Institute of Technology. C. D. Coryell, D. N. Hume, J. D. Sheehan, and C. G. Swain, Nuclear Chemistry Research.

Massachusetts Institute of Technology. T. K. Sherwood, Mechanism of Mass Transfer to Drops.

Michigan State College. C. H. Brubaker, Investigations into Aperiodic Oxidation States.

Michigan State College. J. L. Dye, Thermodynamic Investigation of Dilute Solutions of the Alkali Metals in Liquid Ammonia.

Michigan State College. M. T. Rogers, A Physico-Chemical Investigation of Interhalogen Compounds.

Michigan, University of. R. B. Bernstein, Fundamental Research on Isotopic Reactions.

Michigan, University of. P. J. Elving, Polarographic Behavior of Organic Compounds.

Michigan, University of. W. W. Meinke, Nuclear Chemical Research.

Michigan, University of. E. F. Westrum, Low Temperature Chemical Thermodynamics.

New Hampshire, University of. H. M. Haendler, Infra-red Spectroscopy of Inorganic Fluorides.

New York State College for Teachers. O. E. Lanford, Concentration of Nitrogen 15 by Chemical Exchange.

North Carolina State College. F. P. Pike, Performance of Contractors for Liquid-Liquid Extraction.

North Carolina, University of. K. Knox, The Preparation and Properties of Compounds of Technetium and Rhenium.

Northwestern University. M. Dole, The Mechanism of High Energy Radiation Effects on Polyethylene.

Northwestern University. R. G. Pearson, and F. Basolo, Mechanism of Substitution Reactions of Inorganic Complexes.

Notre Dame, University of. M. Burton, Radiation Chemistry Studies.

Ohio State University. R. J. Kline, The Reactions of Uranium with Solutions of Ammonium Salts in Liquid Ammonia.

Oklahoma Agriculture & Mining College. E. M. Hodnett, The Isotope Effect in the Study of Chemical Reactions.

Oklahoma Agriculture & Mining College. T. E. Moore, The Separation of Inorganic Salts by Liquid-Liquid Extraction.

Oklahoma, University of. J. R. Nielsen, Spectroscopic Properties of Fluorocarbons and Fluorinated Hydrocarbons.

Oregon State College. T. H. Norris, A Study of Generalized Acid-base Phenomena with Radioactive Tracers.

Oregon, University of. D. F. Swinehart, Study of Gaseous Chemical Reaction Kinetics, Using a Mass Spectrometer.

Pennsylvania State University. T. F. Bates, An Investigation of the Mineralogy and Petrography of U-Bearing Shales and Lignites.

Pennsylvania State University. W. C. Fernelius, Stabilities of Coordination Compounds and Related Problems.

Pennsylvania State University. B. F. Howell, Studies of the Dielectric Constant of Rocks and Minerals.

Pennsylvania State University. C. R. Kinney, An Investigation of the Chemical Nature of the Organic Matter of Uraniferous Shales.

Pennsylvania State University. W. W. Miller, Chemical Reactions Induced in Condensed Systems by B-decay.

Pennsylvania State University. H. D. Wright, Mineralogy of U-Bearing Deposits in the Boulder Batholith, Montana.

Pennsylvania, University of. J. O'M. Brockris, A Study of the Structure of Molten Salts & Silicates.

Pittsburgh, University of. H. Freiser, The Development of Organic Reagents for Use in Inorganic Analysis.

Pittsburgh, University of. R. Levine, Synthesis of Beta-Diketone and Beta-Ketoesters with Heterocyclic Nuclei.

Princeton University. J. Turkevich, Study of Nucleation Processes.

Princeton University. J. Turkevich, Temporary and Permanent Effects Produced by Radiation on Solids.

Providence College. M. A. Fineman, The Nature of Gaseous Negative Ions Formed by Electron Impact.

Purdue University. H. C. Brown, Chemistry of Polyvalent Metal Halides.

Purdue University. J. W. Cobble, Chemistry and Nuclear Chemistry of the Heavy Elements.

Purdue University. T. DeVries, Polarographic Studies in Non-Aqueous Solvents.

Purdue University. W. F. Edgell, Studies in Molecular Spectroscopy.

Purdue University. W. H. Johnston, Gas Phase Exchange Reactions.

Reed College. A. F. Scott, The Diffusion of Cathodic Hydrogen Through Metals.

Rensselaer Polytechnic Institute. H. M. Clark, Extraction of Inorganic Substances by Organic Solvent.

Rochester, University of. E. O. Wiig, Radiochemistry.

Rutgers University. E. R. Allen, Polar Inorganic Molecules.

Rutgers University. Wm. Rieman, Analytical Chemistry of the Polyphosphates.

South Carolina, University of. O. D. Bonner, Fundamental Studies of Ion Exchange Equilibria.

Southern California, University of. H. L. Friedman, Solutions of Inorganic Electrolytes in Solvents of Low Dielectric Constant.

Southern California, University of. W. K. Wilmarth, Homogeneous Solution Reactions of Molecular Hydrogen.

Stevens Institute of Technology. E. R. Johnson, Effect of Radiation on Solids.

Syracuse University. B. P. Burtt, Mechanism of Gaseous Radiation Chemical Reactions and the Chemical Reactions of Electrons.

Syracuse University. L. Gordon, Coprecipitation Studies.

Syracuse University. H. Linschitz, Photochemical Reactions of Complex Molecules in Condensed Phase.

Tennessee, University of. J. F. Eastham, Determination and Application of Separation Factors for Some Chemical Fractionations of Hydrogen Isotopes.

Tennessee, University of. G. K. Schweitzer, Study of Radiocolloids.

Tennessee, University of. H. A. Smith, Catalytic Reactions Involving Deuterium and Vapor Pressure Studies.

Tennessee, University of. P. B. Stockdale, Investigation of the Chattanooga Black Shale of Tennessee as a Source of Uranium.

Texas, University of. G. W. Watt, Unusual Oxidation States of Transitional Elements.

Tufts College. T. R. P. Gibb, Jr., Research on the Preparation of Uranium Hydride; Research on Hydrides.
Utah, University of. H. Eyring, Studies on Surface Chemistry.
Utah, University of. R. B. Parlin, Induction of Chemical Reactions by High Frequency Discharges in Gases.
Utah, University of. A. L. Wahrhaftig, Ionization and Dissociation of Molecules by Electron Bombardment.
Vanderbilt University. E. A. Jones, Raman Spectra of Some Inorganic Fluorine Compounds.
Vanderbilt University. M. D. Peterson, Radiation Stability and Inorganic Radiochemistry.
Washington State College. H. W. Dodgen, The Formulae and Stability of Complex Ions in Solution.
Washington University. J. W. Kennedy, Generation of High Voltages by Means of Nuclear Radiations.
Washington University. J. W. Kennedy, Study of Reaction Kinetics Using Stable Isotope Tracers.
Western Reserve University. E. L. Pace, Thermodynamic Properties of Gases Absorbed on Solids.
Wisconsin, University of. F. Daniels, Studies on the Geochemistry of Uranium and the Recovery of Uranium from Low Grade Ores.
Wisconsin, University of. J. O. Hirschfelder, Quantum Mechanical and Semiempirical Determination of Intermolecular Forces.
Wisconsin, University of. E. L. King, Studies of Rates and Equilibria in Inorganic Reactions in Solution.
Wisconsin, University of. J. W. Willard, Application of Radioactive Isotopes to Chemical Problems.
Yale University. H. S. Harned, Diffusion Coefficients of Electrolytes and Molecules.

Metallurgy

Alfred University. V. D. Frechette, Graphitization of Carbon.
Armour Research Foundation. D. J. McPherson, Heat Treatment of Zirconium Base Alloys.
Bausch & Lomb Optical Company. N. J. Kreidl, Irradiation Damage to Glass.
Brown University. R. Truell, Radiation Effects in Solids.
Buffalo, University of. S. Mrozowski, Basic Principles of Manufacture of Carbons.
California, University of. E. Parker, Creep of Alloys.
California, University of. J. A. Pask, The Mechanics of Metal-Ceramic Bonding.
California, University of. A. W. Searcy, The Gaseous Species Above High Melting Solids.
California, University of. J. Washburn, An Investigation of the Origin of Dislocations in Crystals and Correlation of Properties with Dislocation Density and Distribution.
Canisius College. H. A. Szymanski, Investigations in Irradiated Vitreous Silica.
Carnegie Institute of Technology. A. Arrott, Research on Properties of Rare Metals.
Carnegie Institute of Technology. B. Coles, X-Ray Studies of Lattice Imperfections.
Carnegie Institute of Technology. G. Derge, Electrochemical Studies of Non-Aqueous Melts.

Carnegie Institute of Technology. C. L. McCabe, The Standard Free Energy of Formation of Certain Rare Earth Carbides.

Carnegie Institute of Technology. S. Pearlstein, Radiation Damage Effects.

Carnegie Institute of Technology. F. N. Rhines, The Fundamental Study of the Early Stages of Sintering.

Carnegie Institute of Technology. R. Smoluchowski and M. Simnad, Effects of Irradiation on Surface Reactions.

Case Institute of Technology. W. M. Baldwin, Scaling of Zirconium at Elevated Temperatures.

Chicago, University of. C. S. Smith, Research on the Science of Materials.

Colorado, University of. W. F. Love, Research on Metals and Alloys at Low Temperatures.

Columbia University. R. B. Gordon, Ultrasonic Measurements on Liquid Metals.

Franklin Institute. R. L. Smith and F. E. Jaumot, Basic Research in Solid State Physics.

General Electric Company. D. Turnbull, Fundamental Metallurgical Research.

Illinois, University of. P. A. Beck, Annealing of Cold Worked Metals.

Illinois, University of. D. Lazarus and F. Seitz, Mechanism of Substitutional Diffusion in Metals.

Illinois Institute of Technology. T. J. Neubert, Imperfections in Solids.

Illinois, University of. T. A. Read, Diffusionless Phase Changes in Non-Ferrous Metals and Alloys.

Illinois, University of. F. Seitz, Research on Radiation Damage.

Massachusetts Institute of Technology. B. Averbeck, Fundamentals of Cold Working and Recrystallization.

Massachusetts Institute of Technology. Z. S. Basinski, Mechanical Properties of Metals at Low Temperatures.

Massachusetts Institute of Technology. M. B. Bever, Thermodynamics of Metal Solutions.

Massachusetts Institute of Technology. M. Cohen, Solid Solutions and Grain Boundaries.

Massachusetts Institute of Technology. A. R. Kaufmann, The Physical Metallurgy of Uncommon Metals.

Massachusetts Institute of Technology. F. H. Norton, The Measurements of Thermal Conductivity of Refractories.

Massachusetts Institute of Technology. F. H. Norton, Metal-Ceramic Interactions at Elevated Temperatures.

Massachusetts Institute of Technology. B. E. Warren, Nature of Distortion in Radiation Damaged Materials.

New York University. J. P. Nielsen, The Origin of Secondary Recrystallization Nuclei.

New York University. B. R. Sundheim, Thermodynamic Properties of Sodium-Potassium Alloys.

North Carolina State College. K. O. Beatty, Jr., Measuring the Thermal Conductivity of Poor Conductors.

Ohio State University. E. C. Mack, Jr., Investigation of Separative Processes.

Ohio State University. C. H. Shaw, Soft X-Ray Spectra of Metals and Alloys.

Oregon, University of. P. Van Rysselberghe, Corrosion of Zirconium.

Pennsylvania State University. C. R. Kinney, Factors Affecting the Mechanism of Graphitization and the Heterogeneous Gas Reactions of Graphite.

Pennsylvania State University. P. L. Walker, Jr., and J. A. Hipple, Study of Release of Chemisorbed Gases on Graphites by Thermal and Chemical Treatment.

Pittsburgh, University of. W. E. Wallace, Application of Chemical Thermodynamics to the Study of Metallic Alloy Formation.

Purdue University. R. E. Grace, Diffusion of Liquid Alloys.

Purdue University. K. Lark-Horovitz, Basic Radiation Damage Studies.

Rensselaer Polytechnic Institute. H. B. Huntington, Anisotropic Self-Diffusion in Metals.

Rutgers University. S. Weissmann, The Fundamental Study of Radiation Damage of Metals and Alloys by Means of Special X-Ray Diffraction Techniques.

Tennessee, University of. E. E. Stansbury, Studies on the Direct Measurement of the Energy Changes Resulting from Plastic Deformation and Phase Transformations.

Tufts College. T. R. P. Gibb, Jr., Basic Properties of Light Metal Hydrides.

Utah, University of. I. B. Cutler, Recrystallization and Sintering of Oxides.

Virginia, University of. A. T. Gwathmey, The Growth and Chemical Properties of Nearly Perfect Crystals.

Wichita, University of. L. L. Lyon, The Permeability Method of Determining Surface areas of Finely Divided Materials.

Yale University. W. D. Robertson, Specific Heat of Liquid Metals and Alloys.

Physics

Brown University. R. A. Peck, Precision Measurements of Neutron Interactions.

California Institute of Technology. J. W. DuMond, Precision Nuclear Spectroscopy.

California Institute of Technology. R. F. Bacher, High Energy Physics.

California, University of. C. D. Jefferies, Nuclear Moments.

California, University of. J. A. Jungerman, Beta-ray Spectrometry.

California, University of. J. R. Richardson, High Energy Physics Research.

Carnegie Institute of Technology. E. Creutz, Synchrocyclotron Research.

Carnegie Institute of Technology. G. Hinman, Beta-ray Spectroscopy.

Case Institute of Technology. E. C. Gregg, Jr., Interaction of High Energy Gamma Rays and Electrons with Matter.

Chicago, University of. S. K. Allison, Reactions of the Light Nuclei.

Chicago, University of. G. Wentzel and M. Goldberger, Theoretical Research in Elementary Particle Physics.

Columbia University. W. W. Havens, Nuclear Physics Research.

Columbia University. C. H. Townes, Nuclear Properties by Microwave Techniques.

Connecticut, University of. S. S. Friedland, Inelastic Scattering of Neutrons.

Duke University. H. W. Newson, Shell Structure and Fast Neutron Cross Section.

Florida State University. A. S. Green and M. A. Melvin, Analysis of Nuclear Forces.

Florida, University of. D. C. Swanson, Electrostatic Generator Program.

Franklin Institue. C. E. Mandeville, Neutron Scattering Measurements.

Iowa, State University of. J. A. Jacobs, Research in Nuclear Structure.

Johns Hopkins University. G. H. Dieke, Spectra of Molecules.

Johns Hopkins University. G. H. Dieke, Study of Nuclear Properties.

Johns Hopkins University. S. Hanna, Study of Neutron Reactions.

Kansas State College. C. M. Fowler, Nuclear Spectroscopy.

Kentucky Research Foundation. B. D. Kern, Study of Nuclear Enegry Levels.

Louisiana State University. R. C. Mobley, Neutron Scattering Project.

Massachusetts Institute of Technology. G. R. Harrison, Echelle Spectroscopy.
Michigan, University of. D. M. Glaser, Bubble Chamber Development.
Michigan, University of. R. W. Pidd, Electron Synchrotron.
Michigan, University of. W. C. Parkinson, 42-inch Cyclotron Program.
Minnesota, University of. J. H. Williams, 60 Mev Proton Linac.
National Academy of Sciences. Kay Way, Nuclear Data Compilation.
Nebraska, University of. T. Jorgenson, Jr., Mechanism of Energy Transfer of Slow Ions.
North Carolina, University of. A. V. Masket, Measurement of Inelastic Neutron Scattering.
Northwestern University. E. N. Strait, Completion of 5 Mev Electrostatic Generator.
Notre Dame University. B. Waldman, Remodeling of Electrostatic Generator.
Ohio State University. J. N. Cooper, Nuclear Spectroscopy.
Pennsylvania State University. R. Pepinsky, Neutron Single Crystal Diffraction.
Princeton University. M. G. White, Nuclear and Fundamental Particle Physics.
Purdue University. E. Bleuler, Research in Nuclear Physics.
Purdue University. K. Lark-Horovitz, Modification of Purdue Cyclotron.
Purdue University. K. Lark-Horovitz, Linear Electron Accelerator.
Purdue University. R. M. Whaley, Research with Synchrotron.
Rice Institute. T. W. Bonner, Nuclear Physics Research.
Rochester, University of. R. E. Marshak, High Energy Nuclear Physics.
Stanford University. E. L. Ginzton, Electron Linear Accelerator Studies.
Texas, University of. E. L. Hudspeth, Fast Neutron Interactions.
Vanderbilt University. C. D. Curtis, Research with Cockcroft-Walton Generator.
Vanderbilt University. R. T. Lagemann, Precision Beta-ray Spectroscopy.
Virginia, University of. F. L. Hereford, Interaction of Polarized Photons with Matter.
Washington, University of. J. H. Manley, 60-inch Cyclotron Program.
Wisconsin, University of. J. R. Dillinger, Low Temperature Physics.
Wisconsin, University of. W. F. Fry and W. D. Walker, High Energy Interactions.
Wisconsin, University of. R. G. Herb, Experimental Nuclear Research.
Wisconsin, University of. D. A. Lind, Coulomb Excitation and Neutron Scattering.
Wisconsin, University of. R. G. Sachs, Theory of Light Nuclei.
Yale University. E. R. Beringer, Heavy Ion Accelerator.
Yale University. G. Breit, Theory of Nuclear Reactions.
Yale University. H. L. Kraybill and E. Fowler, High Energy Physics.
Yale University. H. L. Schultz, Neutron Cross-Section Measurements.
Yale University. W. W. Watson, Isotope Separation and Use.

BIOLOGY, BIOPHYSICS, MEDICINE, AND RADIATION INSTRUMENTATION RESEARCH CONTRACTS

Biology

Agriculture, U. S. Department of, Agricultural Research Administration, Soil and Water Conservation Branch. Accumulation and Movement of Fission Products in Soils and Plants.
Agriculture, U. S. Department of, Agricultural Research Administration, Animal and Poultry Research Branch. The Intermediary Metabolism of Proteins and Amino Acids in Avian and Mammalian Species.

Alabama Polytechnic Institute, Agriculture Experiment Station. E. J. Cairns, Utilization of Radioactive Tracer Techniques in Investigations of the Feeding Habits of Non-Gall-Forming Plant Parasitic Nematodes.

Alabama Polytechnic Institute, Agriculture Experiment Station. H. E. Sauberlich, Radioisotope Studies on Amino Acid Imbalances and Other Factors Affecting the Metabolism of Amino Acids in Microorganisms and Animals.

American Meat Institute Foundation (Chicago). B. S. Schweigert, Relation of Vitamin B–12 to Nucleic Acid Metabolism.

Amherst College. G. E. Kidder, Studies on Nucleic Acid and Free Nucleotide Synthesis in Normal Tissue and in Tumor Tissue, Using Carbon 14.

Amherst College. H. H. Plough, Genetic Effects of Acute and Chronic Low Level Irradiation with Cobalt 60.

Arizona, University of. W. H. Fuller and W. T. McGeorge, Utilization of Phosphorus from Biological Material and Uptake of Strontium by Various Crops.

Arizona, University of. E. B. Kurtz, The Synthesis of Fatty Acids in Higher Plants.

Arkansas, University of. F. E. Clayton, Developmental-Genetic Study of the Effects of X-Ray Irradiation in *Drosophila virilis* and *Bufo valliceps.*

Arkansas, University of. P. M. Johnson, The Utilization of Radioisotopes by Vertebrate Embryos.

Arkansas, University of. Jacob Sacks, Studies on the Phosphorylation Cycle in the Intact Animal Using Radioactive Phosphorus.

Boyce Thompson Institute. G. L. McNew, Use of Tracer Labeled Fungicides in Determining the Mechanics of Protecting Plants from Fungus Diseases.

Brigham Young University. A. L. Allen, The Effects of X-Irradiation upon Embryonic Development in the Paradise Fish, *Macropodus opercularis.*

Brown University. M. H. Hatch, Penetration of the Gut Wall by Intestinal Bacteria after X-Irradiation.

Brown University. J. W. Wilson, The Role of the Intestinal Flora in Radiation Injury.

California Institute of Technology. G. W. Beadle, The Genetic and Cytological Effects of High Energy Radiation.

California Institute of Technology. Henry Borsook, The Biological Synthesis of Protein.

California, University of (Berkeley). E. A. Adelberg, Enzymatic Changes Associated with Radiation Induced Mutations.

California, University of (Davis). A. C. Anderson and G. H. Hart, The Effect of Radiation on Work Capacity and Longevity of the Dog.

California, University of (Berkeley). H. A. Barker, W. C. Hassid and C. C. Delwiche, Tracer and Enzymatic Studies on the Metabolism of Plants and Bacteria.

California, University of (Davis). A. S. Crafts, The Use of Radioactive Isotopes and Other Indicators to Study Absorption and Distribution of Herbicidal Chemicals in Plants.

California, University of (Berkeley). W. G. Dauben, Mechanism of Biosynthesis of Polycyclic Compounds.

California, University of (Berkeley). Louis Jacobson and Roy Overstreet, Study of the Internal or Metabolic Factors and the External or Environmental Factors Affecting Ion Absorption by Plants.

California, University of (Berkeley). L. M. Julian, R. W. Brauer and J. S. Krebs, Distribution Studies of the Reticuloendothelial System at Various Stages of Development in Relation to the Problem of the Dissociation of Liver Functions.

California, University of (Davis). Max Kleiber, Intermediary Metabolism of Organic Compounds and Biological Synthesis in Farm Animals.

California, University of (Riverside). R. B. March, Use of Radioactive Tracers in Studies of the Mode of Action of Organic Insecticides.

California, University of (Berkeley). A. D. McLaren, Investigation of the Mechanism of the Effect of Ultraviolet Light on Enzymes and Viruses.

California, University of (Berkeley). Roy Overstreet, Study of the Decontamination of Soils Containing Radioactive Elements and Salts.

California, University of (Davis) A. H. Smith, Radiosensitivity of the Hen's Oviduct.

California, University of (Berkeley). P. R. Stout, Micronutrient Element Nutrition of Plants as Determined by Essential and Nonessential Soil-Borne Heavy Metals of Importance in Plant Nutrition.

California, University of (Los Angeles). S. G. Wildman, The Study of Plant Virus as Approached by the Study of the Normal Plant Proteins.

Central Michigan College of Education. L. L. Curry, A Proposed Key for the Classification of the Immature Forms of *Tendipedidae* (*Chironomidae: Diptera*).

Chicago, University of. Hans Gaffron, Effect of Blue and Dark Red Light upon Reactivation of Ultraviolet Treated Photosynthetic Microorganisms.

Chicago, University of. E. M. K. Geiling, Biosynthesis of Radioactive Drug Compounds.

Chicago, University of. J. O. Hutchens, The Entropy of Amino Acids and Proteins.

Chicago, University of. B. L. Strehler, Studies in Photobiochemistry and Bioenergetic Problems.

Christian Brothers College. Edward Doody, Uranium Complexes with Amino Acids and Peptides.

City of Hope Medical Center (Duarte, Calif.). W. D. Kaplan, (a) The Effect, upon the Mutation Rate, of Removal at Time of Irradiation of Peroxides from Irradiated Germ Cells; (b) A Comparison of Patterns of Free Amino Acids and Other Metabolites in Several Minute Stocks of *Drosophila melanogaster* at Various Stages of Development and the Influence of X-Irradiation upon These Patterns.

Clemson Agricultural College. J. G. Dinwiddie, Jr., Investigation of the Mode of Action of Maleic Hydrazide as a Plant Growth Regulator.

Clemson Agricultural College. J. B. Whitney, Jr., Overwintering of *Xanthomonas pruni*, the Causal Organism of Bacterial Spot of Peaches.

Columbia University. R. F. Dawson, Pathways of Alkaloid Biosynthesis.

Columbia University. Theodosius Dobzhansky, The Population Genetics of Species of Drosophila.

Columbia University. L. C. Dunn, Studies of Mutations in Populations of Wild House Mice.

Columbia University. C. G. King, To Identify Precursors and End-Products Containing Radiocarbon, in Studies of the Role of Glucose, Ascorbic Acid, etc., in Metabolism.

Columbia University. David Rittenberg, The Activation of Hydrogen by Biological Catalysts.

Columbia University. J. H. Taylor, Nucleic Acid and Protein Synthesis in Individual Cells and Chromosomes Studied by Radioactive Tracers and Autoradiographs.

Connecticut, University of. A. E. Schwarting, A Study of Alkaloidal Synthesis in *Claviceps purpurea*.

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Connecticut Agricultural Experiment Station. A. E. Dimond and P. E. Waggoner, Therapy of Plant Disease by Nuclear Radiations.

Cornell University, New York State Agricultural Experiment Station. John Einset, The Induction and Testing of Somatic Mutations in Apples, Grapes and Other Economic Plants.

Cornell University. M. R. Zelle, Cytological and Genetic Studies of Bacteria as Related to Effects of Radiation.

Delaware, University of. A. M. Clark, The Relation of Genome Number to Radiosensitivity in Habrobracon.

Duke University. P. J. Kramer, The Relationship Between Root Structure and the Absorption of Minerals by Plants.

Duke University. K. M. Wilbur and Frederick Bernheim, The Effects of Ultraviolet Light and Gamma Rays on Cell Lipids and the Physiological Action of Irradiated Lipids.

Emory University. A. V. Beatty, Studies of the Influence of Oxygen Level and Temperature on the Effects of Ionizing Radiation.

Florida, University of. G. K. Davis, R. L. Shirley and A. Z. Palmer, Concentration of Mineral Elements in the Fetus and the Relationship to Placental Transfer of These Elements.

Florida, University of, Agricultural Experiment Station. A. T. Wallace and F. H. Hull, Recovery of Radiation Induced Micromutations in Oats by Recurrent Selections.

Fordham University. L. R. Cerecedo, Fate of Thiamine and Thiamine Analogs in the Animal Body: Mechanism of Thiamine Inhibition by Thiamine Analogs.

Fordham University. F. F. Nord, Investigation on Enzymatic Degradation of Native and Chemically Modified Proteins.

Georgia, University of. E. P. Odum, J. J. Paul and D. C. Scott, A Study of the Ecological Change on the AEC Savannah Area Through the Use of Indices for Total Community Function and Measurements of the Biomass of Key Populations.

Harvard University—Bussey Institution. Karl Sax, The Biological Effect of Radiation; Effects of Irradiation on Chromosomes.

Hawaii, University of. M. S. Doty, (a) The Utilization and Evaluation of Isotope Techniques for the Determination of Algal Productivity in the Tropical Pacific; (b) The Role of Benthic Algae in the Central Pacific.

Hawaii, University of, Eniwetok Marine Biological Laboratory. R. W. Hiatt, Technical and Administrative Functions of Eniwetok Marine Biological Laboratory Operations.

Hawaii, University of. R. W. Hiatt, Radioisotope Uptake in Marine Organisms with Special Reference to the Passage of Such Isotopes as are Liberated from Atomic Weapons through Food Chains Leading to Organisms Utilized as Food by Man.

Howard University. W. M. Booker, The Relation of Ascorbic Acid to Cholesterol.

Howard University. L. A. Hansborough, The Effect of Labeling the Germ Cells with Radioactive Isotopes on Fertilization and Development.

Howard University. Nathan Lavenda, The Influence of Radioiodine and Radiophosphorus on the Hematopoietic Systems of Leukemically-Resistant and Susceptible Strains of Mice.

Illinois, University of. I. C. Gunsalus, Intermediary Metabolism of Carbohydrates.

Illinois, University of. R. G. Hansen, Utilization of Carbon 14 in Studies of the Metabolism of Lactose.

Illinois, University of. B. C. Johnson, Nutritional Biochemistry on the Metabolism of Vitamins and Amino Acids.

Illinois, University of. George Wolf, Metabolism of Amino Acids Labeled with Radioactive Carbon.

Indiana University Foundation. Felix Haurowitz, Biosynthesis and Specificity of Normal and Immune Proteins.

Indiana University Foundation. H. J. Muller, The Influence of Radiation in Altering the Incidence of Mutations in Drosophila.

Indiana University Foundation. Roy Repaske, Energy Transport in Bacterial Cell-Free Extracts.

Indiana University Foundation. T. M. Sonneborn, Cellular Heredity in Paramecium.

Interior, U. S. Department of, Fish and Wildlife Service. W. A. Chipman, Accumulation of Fission Products by Marine Fish and Shellfish.

Iowa State College of Agriculture and Mechanic Arts. Samuel Aronoff, Plant Biochemistry of Boron.

Iowa State College of Agriculture and Mechanic Arts. P. A. Dahm, A Mode of Action Study of Radioisotope-Labeled Organic Insecticides with Emphasis on the Problem of Insecticide Resistance.

Iowa State College of Agriculture and Mechanic Arts. J. W. Gowen and Janice Stadler, Quantitative Study of Lifetime Sickness and Mortality and Progeny Effects Resulting from Exposure of Animals to Penetrating Irradiation.

Johns Hopkins University. Robert Ballentine, Cell Membrane Permeability and Accumulation of Ions.

Johns Hopkins University. B. F. Chow, Purification of Intrinsic Factor in Gastric Juice.

Johns Hopkins University. Theodore Enns and Francis Chinard, A Study of Relative Diffusion Rates of Isotopes from Capillaries.

Johns Hopkins University. H. B. Glass, The Action of Radiation and Other Mutagenic Agents; (a) in inducing Mutation in Drosophila Females, and (b) in Controlling the Action of a Specific Gene Responsible for Suppressing Uncontrolled Growth.

Johns Hopkins University. R. M. Herriott, (a) The Transformation of E. coli B from Virus Sensitive to Virus Resistant or Vice Versa; (b) Chemical and Nutritional Studies of Bacterial Viruses.

Johns Hopkins University. W. D. McElroy, Biochemical Changes Resulting from Mutations Induced by X-Rays, Ultraviolet, and Nitrogen Mustard.

Johns Hopkins University. C. P. Swanson, Modification by Supplementary Agents of the Rates of Induced Chromosome and Gene Changes.

Johns Hopkins University. Robert Van Reen, Factors Influencing the Metabolism of Copper and Iron.

Kansas State College of Agriculture and Applied Science. R. E. Clegg, Phosphoproteins of the Embryonated Egg.

Kansas State College of Agriculture and Applied Science. M. F. Hansen, Mode of Action of Anthelmintics; Carbon Disulfide.

Kansas State College of Agriculture and Applied Science. C. C. Roan, Use of Radioactive Tracers in Investigations of the Mode of Action of Insecticides with Emphasis on Potential Systematic or Chemotherapeutic Action.

Long Island Biological Association, Inc. M. Demerec, Symposium on Population Genetics—The Nature and Causes of Genetic Variability of Populations.

Long Island Biological Associaion, Inc. Bruce Wallace, Adaptive Value of Experimental Populations Exposed to Radiations.

Longwood College (Farmville, Va.). R. T. Brumfield, Effects of Radiation on Root Growth of Higher Plants.

Louisiana State University. H. E. Wheeler, Investigations of the Toxin Theory of Plant Disease Using Labeled Plant Pathogens.

Marine Biological Laboratory. P. B. Armstrong, Studies on the Physiology of Marine Organisms Using Radioisotopes.

Marquette University School of Medicine. Michael Laskowski, Nucleolytic Enzymes.

Marquette University. J. P. O'Brien, Temperature Prevailing During Exposure as a Modifying Factor in the Dose-Response Relationships of X-Rayed Mammalian Skin.

Maryland, University of. J. C. Shaw, Studies on the Physiology and the Nutrition of Lactating Ruminants.

Maryland, University of. H. G. Gauch and R. W. Krauss, The Influence of Inorganic Nutrients on the Translocation of Organic Materials in Plants.

Maryland, University of. Edward Steers, A Study of the Metabolic Precursors of the Benzenoid Carbons of Tryptophan.

Massachusetts Institute of Technology. B. E. Proctor, Fundamental Studies of Ionizing Radiations on Bacteria.

Massachusetts, University of. P. A. Swenson, Effects of Ultraviolet Radiations on Phosphate Turnover of Yeast Cells in the Presence of Galactose.

Michigan State College. R. U. Byerrum and C. D. Ball, A Study of Transmethylation in Plants Using Carbon 14 as a Tracer.

Michigan State College. J. L. Fairley, The Role of Various Aliphatic Acids in Pyrimidine Biosynthesis.

Michigan State College. L. W. Mericle, Effects of Irradiation on Developing Plant Embryos.

Michigan State College. H. B. Tukey, (a) The Absorption and Utilization of Radioactive Minerals Applied to the Leaves of Plants; (b) The Absorption and Utilization of Ruthenium by Plants; (c) The Leaching of Nutrients from Leaves of Plants.

Michigan, University of. F. C. Evans, W. B. McIntosh and W. J. Schull, The Effect of Irradiation on Genetically Heterogeneous Populations of the Deermouse, *Peromyscus maniculatus.*

Michigan, University of. J. V. Neel, (a) The Estimation of the Rate of Mutation of Certain Human Genes; (b) The Estimation of the Genetic Effects of Radiation on Man.

Minnesota, University of. P. D. Boyer, Study of Enzymic Phosphorylation Reactions with Oxygen 18 and Phosphorus 32.

Minnesota, University of. R. S. Caldecott, The Genetic Basis and Practical Significance of Mutations Induced in Oats and Barley with Ionizing Radiations.

Minnesota, University of. J. J. Christensen and E. C. Stakman, Effects of Radioactive Substances on Plant Pathogens and Other Microorganisms.

Minnesota, University of. W. E. Peterson, *et al.*, Study of Milk Formation by the Use of Radioactive Carbon Compounds.

Minnesota, University of, Hormel Institute. Herman Schlenk, Studies in Lipid Metabolism by Means of Radioactive Tracers.

Minnesota, University of, Institute of Agriculture. M. O. Schultze, The Cause and Nature of an Aplastic Anemia of the Bovine.

Mississippi, University of. D. R. Parker, Chromosome Breakage in Oocytes in Drosophila.

Missouri, University of. Samuel Brody, Determination of Thyroid Activity in Farm Animals by the Use of Radioactive Tracers.

Missouri, University of. C. W. Turner, Study of the Inheritance of Productive Processes in Domestic Animals by Endocrine Methods Using Radioactive Isotopes as Tracers.

Morehouse College. J. H. Birnie, The Correlation of Histological Differentiation in the Thyroid Gland of Fetal Rats with the Beginning of Function.

Nebraska, University of. E. F. Frolik and Rosalind Morris, The Genetic Effects of Thermal Neutron Irradiation of Crop Seeds.

Nebraska, University of. C. O. Gardner and D. G. Hanway, Evaluation of Effects of Radiation on Quantitative Characters in Corn, Soybeans, and Other Crops as Related to Breeding Improved Varieties.

Nevada, University of. V. R. Bohman, Range Livestock Production Adjacent to Nevada Proving Grounds.

New York Medical College. Carl Neuberg, Factors Influencing the Solubility of Heavy Metal Compounds and Their Metabolism.

New York University. B. W. Zweifach and B. P. Sonnenblick, Histochemical Studies of Metabolic Alterations in Rats Receiving Lethal and Sublethal Doses of Radiation, with Emphasis on Terminal Vascular Bed.

North Carolina State College of Agriculture and Engineering. W. C. Gregory, (a) The Comparative Effect of Irradiation upon Mutation Frequency, Total Genetic Variance, and Progress from Selection in Different Genotypes of Peanuts and Their Hybrids; (b) The Genetic Characteristics of Radiation Injury Resistance in Peanuts.

North Carolina State College of Agriculture and Engineering. D. S. Grosch, The Genetic and Developmental Effects of Ingested Radioactives in Habrobracon.

North Carolina State College of Agriculture and Engineering. Clayton McAuliffe, The Environmental Factors Influencing Root Behavior.

North Carolina State College of Agriculture and Engineering. S. B. Tove, A Study of the Effect of the Diet on Lipid Metabolism Using Carbon 14.

North Carolina, University of. Maurice Whittinghill, A Study of Genetic Recombination as Influenced by Mutagenic and Nonmutagenic Environmental Agents.

Northwestern University. G. H. Mickey, Comparison of the Delayed Effects Produced by Chemical Mutagens and by X-Rays.

Northwestern University. V. L. Koenig, The Effects of Radiation on Pure Proteins and Nucleic Acids.

Notre Dame, University of. C. S. Bachofer, Mechanisms Involved in the Actions of Radiations on Living Cells.

Oberlin College. G. T. Scott, Studies on the Physiology of Ion Accumulation and Electrolyte Balance in Living Cells.

Ohio Agricultural Experiment Station. O. G. Bentley and A. L. Moxon, Investigations of Vitamin B–12 and Vitamin B–12-like Substances Produced in Ruminants, Using Radioactive Cobalt.

Oklahoma Agricultural and Mechanical College. Robert MacVicar, Isotope Investigation of the Mechanism of Nitrate Reduction in Bacteria.

Oklahoma, University of, Research Institute. J. B. Clark, The Cytology and Genetics of Radiation Resistance in Bacteria.

Oklahoma, University of, Research Institute. Lawrence Rohrbaugh and E. L. Rice, Study of the Translocation of Tagged 2, 4–D and Other Growth Regulators in Plants in Light and Darkness.

Oklahoma, University of, Research Institute. S. H. Wender, Studies on the Role of Certain Polyphenolic Compounds in Plant Metabolism.

Oregon State College. S. B. Apple, Jr., The Effects of Soil Temperature and Morphological Age of Plants on the Uptake and Assimilation of Radioactive Phosphorus.

Oregon State College. J. S. Butts, The Mode of Action of Labeled 2, 4-Dichlorophenoxyacetic Acid and Similar Agents.

Oregon State College. V. H. Cheldelin and B. E. Christensen, Carbohydrate Amino Acid Interrelationships, Using Isotopic Tracers.

Oregon State College. B. E. Christensen, Elmer Hansen and C. H. Wang, Intermediary Metabolism of Organic Acids and Proteins in Certain Fruits Using Isotopic Tracers.

Oregon, University of. D. L. Jameson, An Investigation of the Population Genetics of the Pacific Tree Frog (*Hyla regilla*).

Oregon, University of. F. J. Reithel, An Investigation of Lactose Synthesis in Mammary Gland Homogenates.

Pennsylvania State University. R. J. Flipse, Pathways of Metabolism in Bovine Germ Cells.

Pennsylvania, University of. E. D. DeLamater, Studies on the Cytology and Cytochemistry of Microorganisms Following Irradiation.

Pennsylvania, University of. D. R. Goddard and William Stepka, A Study of Sulfate Reduction and the Biosynthesis of Organic Sulfur Derivatives in Higher Plants.

Pennsylvania, University of. L. V. Heilbrunn, Changes in the Capillary Fragility and the Colloidal Properties of Blood Following Irradiation.

Pennsylvania, University of. Stuart Mudd, The Internal Organization of Normal and Phage-Infected Cells as Influenced by Radiation.

Pennsylvania, University of. P. W. Whiting, Mutation Rates in Mormoniella.

Pennsylvania, University of. D. W. Wilson and Samuel Gurin, Organic Synthesis and Degradation of Radioactive Metabolites.

Pittsburgh, University of. M. A. Lauffer, Study of the Correlation of Radiation Effects with Physical and Chemical Changes in Viruses.

Pittsburgh, University of. E. B. Spiess, Genetic Potential of Certain Populations of *Drosophila persimilis* from the Sierra Nevada of California.

Puerto Rico, University of, Agricultural Experiment Station. J. A. Bonnet and A. R. Riera, Radioactive Iron Studies with Soils and Crops of Puerto Rico.

Purdue Research Foundation. Harry Beevers, Carbohydrate Catabolism in Plants.

Purdue Research Foundation. A. B. Burdick, Genetic Effects of Thermal Neutron Irradiation in Homozygous Tomatoes.

Purdue Research Foundation. Henry Koffler and D. M. Powelson, The Physiology of Hydrogen Bacteria.

Purdue Research Foundation. Henry Koffler and P. A. Tetrault, Use of Radioactive Isotopes in Studying Mold Metabolism with Emphasis on the Assimilatory Mechanisms of Penicillium Chrysogenum and Other Representative Molds.

Reed College. A. F. Scott and A. H. Livermore, The Effect of Ionizing Radiation on Biochemical Compounds.

Rice Institute. R. V. Talmage, Endocrine and Metabolic Studies Utilizing Radioisotopes and Labeled Hormones.

Rochester General Hospital. H. L. Rosenthal, A Study of the Uptake, Turnover, and Metabolism of the Chemical Constituents of Bone.

Roscoe B. Jackson Memorial Laboratory. C. C. Little, Study of Endemic and Epidemic Diseases in Mice.

Roscoe B. Jackson Memorial Laboratory. Meredith Runner, Physiological Studies on Induced Congenital Deformities in Mice.

Roscoe B. Jackson Memorial Laboratory. E. S. Russell and W. S. Murray, The Maintenance of a Genetically Controlled Colony of Mice to Insure the Availability of Strains of Known Constitution to AEC Institutions and Contractors.

Roscoe B. Jackson Memorial Laboratory. E. S. Russell, Attempt to Delineate Inborn Anemias in Mice.

Rutgers University. J. E. Gunckel, Histological and Physiological Effects of Irradiation on Plant Tissues.

Rutgers University. L. F. Hough and J. E. Gunckel, Irradiation as an Aid in Fruit Variety Improvements.

Smithsonian Institution. R. B. Withrow, A Biochemical Investigation of Radiant Energy as it Affects Photomaturation in Green Plants.

Smithsonian Institution. R. B. Withrow, Specific Biological Indicators of Ionizing Radiation and the Mechanism of Its Action.

South Carolina, University of. W. E. Hoy, An Ecological Study of the Flora and Fauna of the Savannah River Project Area.

South Dakota State College. E. I. Whitehead and O. E. Olson, Metabolism of Selenium and Radioactive Sulfur in Plants.

Southern California, University of. H. J. Deuel, Jr., and A. L. S. Cheng, Effect of Radiation on Intestinal Absorption and Metabolism of Fats and Carbohydrates.

Southern California, University of. W. E. Martin, The Action of Ultraviolet Light on Purine and Protein Metabolism in Echinoderm Embryos.

Southern California, University of. M. G. Morehouse, A Study of the Effect of X-Radiation on the Absorption of Glycerides Utilizing Tracer Techniques.

Southern Illinois University. C. C. Lindegren, The Effect of X-Irradiation on a Polyploid Series of Yeast Cultures Containing Determined Amounts of DNA.

Southern Research Institute. H. E. Skipper, Body Retention of Carbon 14.

Southern Research Institute. H. E. Skipper and L. L. Bennett, Jr., The Use of Radioactive Isotopes in a Study of the Sites of Inhibition of Polynucleotide Synthesis in Cells Following Exposure to X-Radiation.

Syracuse University. B. S. Strauss, The Study of Intermediate Carbohydrate Metabolism in Neurospora Using Radioactive Carbon and Biochemical Mutants.

Stephen F. Austin State College (Nacogdoches, Tex.). W. H. McCarley, The Effect of Radiation on a Natural Population of *Peromyscus gossypinus.*

Tennessee, University of. A. W. Jones, A Survey of the Effects of Radiation on Animals Parasitized with *Taenia pisiformis*, on the Parasites of the Irradiated Animals, and on the Parasites *per se.*

Texas A & M College, Agricultural Experiment Station. J. L. Liverman, Biosynthesis, Metabolism and Mechanism of Action of Plant Growth Substances.

Texas, University of. W. F. Blair, Direct and Indirect Effects of Radiation on Genetic and Developmental Systems of Vertebrates.

Texas, University of. J. W. Foster, Studies of the Metabolic Processes in Molds and Fungi with Carbon 14.

Texas, University of. A. R. Schrank, Effects of Various Types of Irradiation On Growth Responses, Metabolism and Electrical Pattern of the *Avena coteoptile* and Earthworms.

Texas, University of. W. S. Stone, Research on Direct and Indirect Effects of Radiations on the Genetic Systems of Organisms.

Texas, University of. Orville Wyss, The Genetic and Biochemical Effects of Radiation on Bacteria.

Utah State Agricultural College. G. W. Cochran, The Use of Radioactive Phosphorus, P–32, in Labeling Plant Viruses to Facilitate Their Isolation by Means of Paper Electrochromatography.

Utah State Agricultural College. L. E. Harris, Effect of Radioactive Elements and Radiation on Ewes Maintained on Different Levels of Nutrition.

Utah State Agricultural College. D. W. Thorne, Use of Radioisotopes in Studying Lime-Induced Chlorosis.

Utah, University of. J. D. Spikes, Radiation Effects of the Photosynthesis and Metabolism of Higher Plants.

Utah, University of. F. E. Stephens, Study of the Frequency of Human Consanguineous Marriages and Its Relation to the Appearance of Recessive Gene Mutations.

Vermont, University of, and State Agricultural College. J. E. Little, Relationship of the Pyruvate Oxidation System to Growth Stimulation by Antibiotics and Other Compounds.

Virginia, University of. J. N. Dent, A Study of the Pituitary Glands of Thyroidectomized Newts.

Washington, State College of. Orlin Biddulph, (a) A Study of Phosphorus Metabolism in the Phloem Tissues of Plants as it is Related to the Translocation of Phosphorus; (b) A Study of the Movement of Tritiated Water in the Phloem of Plants.

Washington, State College of. Robert A. Nilan, A Study of Factors Influencing the Biological Effects of X-Rays.

Washington, University of, (Seattle). E. J. Ordal, The Metabolism of Molecular Hydrogen, Deuterium and Tritium.

Wesleyan University. V. W. Cochrane, Respiratory Pathways in Fungi and Actinomycetes.

Western Biological Laboratories (Culver City, Calif.). B. H. Ershoff, Further Studies of an Unidentified Factor in Liver which Prolongs Survival of Animals Administered Sublethal Doses of X-Irradiation.

Western Reserve University. H. G. Wood and L. O. Krampitz, Intermediary Metabolism of Carbohydrates by Bacteria.

Wisconsin, Uinversity of. R. H. Burris, M. J. Johnson, and P. W. Wilson, Metabolism of Organic Acids in Higher Plants and Microorganisms.

Wisconsin, University of. R. H. Burris and P. W. Wilson, Biological Nitrogen Fixation with Isotope Tracers.

Wisconsin, University of. J. E. Casida, Radiotracer Studies on the Mechanism of Insecticidal Toxicity.

Wisconsin, University of. D. E. Green, Effect of Radiation on Enzymes in the Cyclophorase System.

Wisconsin, University of. A. D. Hasler, Radioisotope Exchange Studies in Lakes.

Wisconsin, University of. J. C. Neess, The Iron, Manganese and Copper Cycles in Aquatic Insect Populations.

Wyoming, University of. Irene Rosenfeld and O. A. Beath, Investigations of the Interrelationship of Sulphur, Phosphorus and Calcium in Selenium Metabolism in Plants and Animals.

Yale University. D. M. Bonner, Relationship of Genes to Biochemical Reactions in Neurospora.

Yale University. N. H. Giles, Jr., Investigations on the Cytogenetic Effects of Radiations.

Yale University. E. C. Pollard, Irradiation of Viruses and Large Molecules.

Biophysics

Agriculture, U. S. Department of, Soil Conservation Service. L. T. Alexander, Collection and Preparation of Samples of Soils, Plants and Animals for Calcium and Strontium Analysis.

California, University of (Los Angeles). Zdenek Sekera, Determination of Suspended Dust Particles by Means of Skylight Polarization.

Chicago, University of. R. E. Zirkle, Proton and Ultraviolet Microbeam.

Columbia University. C. B. Braestrup, Attenuation of Scattered Cobalt 60 Radiation in Lead and Building Materials.

Columbia University. Gioacchino Failla, Biological Action of Ionizing Radiation. Instrumentation for Research.

Columbia University. V. K. LaMer, Filtration of Monodisperse Radioactive Solid Aerosols (Dusts).

Columbia University, Lamont Geological Observatory. Maurice Ewing, Studies of Circulation of the Deeper Oceanic Water.

Columbia University, Lamont Geological Observatory. J. L. Kulp, Distribution of Certain Fission Product Activities.

Commerce, U. S. Department of, National Bureau of Standards. Gladys White, Radiation Data.

Commerce, U. S. Department of, National Bureau of Standards. H. O. Wykoff, Radiation Shielding Problems.

Commerce, U. S. Department of, National Bureau of Standards. R. S. Caswell, Ion Source and Electron Tube.

Commerce, U. S. Department of, National Bureau of Standards. J. W. Motz, Magnetic Spectrometer.

Commerce, U. S. Department of, National Bureau of Standards. S. W. Raskin, Assistance to the National Committee on Radiation Protection.

Commerce, U. S. Department of, National Bureau of Standards. L. L. Marton, Scattering of Low Energy Electrons.

Commerce, U. S. Department of, National Bureau of Standards. E. K. Plyler, Infra Red Measurements.

Commerce, U. S. Department of, U. S. Weather Bureau. Lester Machta, Studies on the Effects of Atomic Weapons on the Weather.

Emory University. H. D. Bruner, Biological Studies on the Distribution of Radioactive Metals.

Florida State University. R. W. Rogers, Alpha-Particle Dosimetry and the Inhibition of Mitosis by Alpha-Particle Irradiation.

Georgetown University. W. C. Hess, Development of Radioisotope Techniques for Counting Bacteria in Water.

Howard University. Herman Branson, Kinetic and Mass Spectrometric Studies of Biophysical Systems with Radioactive and Stable Isotopes.

Idaho State College. A. E. Taylor, Development of Analytical Methods for the Determination of Small Amounts of Strontium, Uranium and Fluoride.

Kansas, University of. F. E. Hoecker, Study of Deposition and Excretion of Bone-Seeking Radioisotopes.

Marquette University, School of Medicine. J. F. Kuzma, The Pathological Effects of Radioactive Isotopes of Calcium and Strontium on Bone and Soft Tissue.

Massachusetts Institute of Technology. R. D. Evans, Radium and Mesothorium Poisoning, and Dosimetry and Instrumentation Techniques in Applied Radioactivity.

Michigan, University of. H. J. Gomberg, High Resolution Detection of Nuclear Radiations.

Pittsburgh, University of. Herman Cember, Hazard from Inhaled Radioactive Particulate Matter.

Rheumatic Fever Research Institute (Chicago). E. L. Hess, The Separation and Characterization as Regards Radiation Sensitivity of the Proteins of Lymphoid Tissue.

Sloan Kettering Institute for Cancer Research, Memorial Hospital. J. S. Laughlin, Equivalence of Absorbed Radiation Energy and Cavity Ionization.

Utah, University of. T. F. Dougherty, Toxicity Studies of Plutonium and Other Radioactive Substances in Animals.

Vanderbilt University. J. I. Hopkins, Nuclear Physics Studies on Instrumentation Problems.

Virginia, University of. Herbert Jonas, Study of the Kinetics and Reactivity of Cell Surface Components as Affected by Ionizing Radiation.

Washington, University of. F. I. Badgley, Determination of Relationships Between Temperature Lapse Rate, Wind Speed and Wind Shear (Atmospheric Turbulence Study).

Woods Hole Oceanographic Institute. A. B. Arons, Studies on the Background Radiation and Flow of Deep Ocean Currents.

Medicine

Albert Einstein Medical Center (Philadelphia). D. M. Sklaroff, The Uptake of Radioactive Rubidium (Rb^{86}) by Tumors of the Breast (Benign and Malignant) in Humans.

Albert Einstein Medical Center (Philadelphia). Charles Weiss, Comparative Enzymatic and Biochemical Studies of Animal Skin Irradiated with Alpha and Beta Particles.

Albert Einstein College of Medicine (New York City). I. M. London and B. A. Lowy, The Metabolism of Adenosine Triphosphate and Related Compounds.

Arkansas Medical School, University of. P. L. Day, Studies on the Biochemical and Nutritional Aspects of X-Radiation Injury.

Beth Israel Hospital Association, Inc., (Boston). H. L. Blumgart, The Use of Iodine 131 in Treatment of Heart Diseases and Follow-up Studies on Biological Effects of Radiation.

Boston University School of Medicine. Isaac Asimov, Radiation-Induced Changes in Nucleic Acids and Their Hydrolysis Products.

Boston University School of Medicine. Fabian Lionetti, Enzymology of the Formed Elements of Human Blood, Dynamics and Biosynthesis of Carbon Labeled Substrates by Human Leucocytes *in vitro*.

Boston University. L. C. Wyman, The Effect of Irradiation on the Growth and Functioning of Transplanted or Regenerated Adrenocortical Tissue in the Rat.

California, University of, School of Medicine (Berkeley). I. L. Chaikoff, Studies on the Induction of Thyroid Cancer and on the Nature of Metabolic Blocks Following Irradiation.

California, University of, (Berkeley). I. L. Chaikoff, Carbohydrate Metabolism as Studied with C–14 Labeled Compounds.

California, University of (Berkeley). Morgan Harris, Growth-Promoting Agents in Adult Tissues.

Cedars of Lebanon Hospital (Los Angeles). H. L. Jaffe, To Investigate, Develop and Evaluate Radioisotopes for Teletherapy.

Chicago Medical School. Philippe Shubik, A Study of the Latent Tumor Cells as Produced by Beta Radiation and a Comparison of the Latent Tumor State with that Produced by Chemical Carcinogens.

Chicago, University of. H. S. Anker, Investigation of the Mechanism of Antibody Synthesis by the Tracer Technique.

Chicago, University of. E. S. G. Barron, Studies on the Mechanism of Action of Ionizing Radiations.

Chicago, University of. P. P. H. DeBruyn, Radiosensitivity of the Lymphocytes.

Chicago, University of. C. P. Miller, Bacteriological Aspects of Radiation Sickness.

Chicago, University of. W. L. Palmer, A Study of the Effect on Gastric Tissues of Irradiation Therapy in Peptic Ulcer.

Chicago, University of. W. H. Taliaferro, The Physiological Factors Involved in Antibody Synthesis and in the Modification of the Immune Process by X-Irradiation.

Chicago, University of. D. W. Talmage, The Effect of Whole Body Ionizing Radiation on Tuberculin Hypersensitivity.

Children's Hospital of Buffalo. C. U. Lowe, Effect of Cortisone, Partial Hepatectomy and X-Radiation Upon Nucleic Acids of Rat Liver.

Children's Medical Center (Boston.) L. K. Diamond, Study of Hypoplastic and Aplastic Inborn Anemias in Humans.

Children's Medical Center (Boston). Jacob Furth, The Effect of Irradiation on Induction of Pituitary Tumors.

Children's Medical Center (Boston). Sidney Farber, The Nature of Bleeding in Pancytopenia with Special Regard for Thrombocytopenia and the Vascular Defect.

Children's Hospital Society of Los Angeles. Phillip Sturgeon, Iron Storage and Reutilization.

Cincinnati, University of, Kettering Laboratory. F. F. Heyroth and J. S. Cass, Research on the Biological Effects of Beryllium and Its Compounds.

Colorado, University of. J. K. Aikawa, A Study of the Abnormal Physiology of Immune Reactions (Immunophysiology).

Colorado, University of. T. T. Puck, Normal and Radiation-Induced Metabolic Processes in Microbiological Systems.

Columbia University, College of Physicians and Surgeons. P. B. Hudson, The Turnover of Specific Proteins, Protein Fractions, and Nucleic Acids in Normal and Malignant Human Testis and Kidney.

Columbia University. Seymour Lieberman, Turnover of Nucleic Acids in Human Ovarian and Endometrial Carcinomas.

Columbia University. David Nachmansohn, Effect of Exposure to Radioactive Material and to X-Ray Irradiation on Nerve Tissue.

Duke University. Philip Handler, Metabolic Studies with Tracer Techniques.

Duke University. J. S. Harris, (a) Metabolism and Physiological Role of Potassium; (b) Metabolism of Renal Insufficiency.

Emory University. A. J. Riopelle, Effect of Radiation on Learned Behavior, Problem-Solving Ability and Neural Mechanisms of Rhesus Monkeys.

Emory University. H. S. Weens, To Investigate and Evaluate Radioisotopes for Teletherapy.

Florida, University of—Cancer Research Laboratory. F. E. Ray, The Use of Isotopes in the Study of the Metabolism of Aromatic Amines.

Garfield Memorial Hospital, Washington, D. C. J. C. Bateman, Investigation of Distribution, Localization and Excretion of Tagged Triethylene Thiophosphoramide Following Injection by Various Routes.

Georgetown University School of Medicine. W. C. Hess, Source of the Liver Glycogen Resulting from the Administration of Cortisone.

Georgetown University School of Medicine. C. A. Hufnagel, W. P. Harvey and B. J. Duffy, Jr., Isotopes in Cardiac Disease.

Georgetown University, Chemo-Medical Research Institute. M. X. Sullivan, A Study of Intermediary Carbohydrate Metabolism by Means of Labeled Compounds.

George Washington University. S. N. Albert, Continuous Blood Volume Recording with Tracers in Patients under Anesthesia and During Surgery, with Special Regard to Specific Physiological Conditions.

George Washington University. L. K. Alpert, The Dose-Incidence Relationship of Beta Radiation-Induced Skin Cancer in the Rat.

George Washington University. P. K. Smith, Studies of the Effect of Radiation on the Biosynthesis and Degradation of Nucleoproteins and Its Modification by Various Agents.

Georgia, Medical College of. W. F. Hamilton, Investigation of the Results of Treating Crippling Emphysema with Iodine 131.

Georgia, Medical College of. S. A. Singal, The Effects of Nutritional Deficiencies on the Synthesis of Phospholipids and Nucleoproteins in the Rat.

Hahnemann Medical College and Hospital. J. S. Roth and H. J. Eichel, The Biochemical Properties of Microsomes and the Effects of Radiation on Them.

Harvard University—Medical School. E. L. Gasteiger, The Effect of Ionizing Radiations on Peripheral Nerve.

Harvard University. J. C. Aub, Study of Metabolic Activities of Living Organisms by Means of Suitable Isotopes.

Harvard University. A. B. Hastings, Research on the Use of Isotopes in Study of Metabolism of Organic Substances in Mammalian Tissues.

Harvard University. A. K. Solomon, *et al*, Research on Biological, Medical, and Biophysical Problems of Isotope Techniques, and on the Use of Isotopes in Medical Problems.

Harvard University. Shields Warren, Research on the Use of Isotopes as Therapeutic and Diagnostic Agents.

Health Research, Inc., Roswell Park Memorial Institute Division (Buffalo). David Pressman, The Localization of Physiologically Active Amounts of Radioactivity in Human Tumors by Means of Radioactive Antibodies.

Health Research, Inc., Roswell Park Memorial Institute Division (Buffalo). T. C. Prentice, The Role of Serum Erythropoietic Factor in the Anemia of Malignancy.

Health Research, Inc., Simon Baruch Research Laboratories (Saratoga Springs, N. Y.). J. M. Reiner, Intracellular Distribution and Enzymatic Function of Cobalt.

Illinois, University of. Percival Bailey, The Effects of Betatron 23 Mev X-Rays upon Tumors of the Central Nervous System of Man and upon the Normal Nervous System of Man.

Illinois, University of. P. G. Kruger, Experimental Research on Synthesis of Boron-Containing Dyes.

Illinois, University of, College of Medicine. S. B. Binkley, The Chemistry and Biological Significance of Carbohydrate Containing Nucleotides and Polynucleotides.

Illinois, University of, College of Medicine. S. R. Rosenthal, A Reevaluation of Radiation Injury (Beta Rays) of the Skin by a Direct Method Approach.

Institute for Cancer Research (Lankenau Hospital) (Philadelphia). Sidney Weinhouse, Origin and Fate of Amino Acids in Plants and Animals.

Institute for Cancer Research (Lankenau Hospital). J. A. Stekol, Metabolic Studies on Ethionine and Derivatives.

Iowa State College. Henry Gilman, Synthesis of Organic Compounds.

Iowa State College. J. G. Graca, Comparative Toxicity of Rare Earth Compounds.

Iowa, State University of. T. C. Evans and P. J. Leinfelder, A Quantitative and Morphologic Study of Radiation Induced Cataracts.

Iowa, State University of, College of Medicine. T. C. Evans, R. E. Hodges and J. T. Bradbury, Radioiodine Studies of Fetal and Other Thyroids.

Jefferson Medical College of Philadelphia. F. W. Sunderman, Metabolic and Cytologic Changes Induced by Metallic Carbonyls.

Johns Hopkins University, School of Medicine. C. L. Conley, (a) Absorption, Utilization, and Excretion of Vitamin B–12; (b) Blood Coagulation, Hemorrhagic Disease.

Johns Hopkins University. J. E. Howard, Investigation of the Mechanism of Bone Deposition and Related Physiological Studies.

Johns Hopkins University. W. H. Price, The Mechanism of the Activation of Latent Epidemic Typhus Infections in the Laboratory Animals and in Humans by Cortisone and X–Ray.

Kansas, University of. F. E. Hoecker, Investigation of Organic Substances Tagged with Iodine 131 by Human Thyroid Gland *in vivo.*

Kansas, University of. Max Berenbom, Effects of Ischemia, Irradiation, and Chemical Irradiation on Cytochemistry of Mammalian Tissues.

Kresge Eye Institute (Detroit). V. E. Kinsey, Effects of Neutrons and Other Radiations on the Ocular Lens.

Lovelace Foundation for Medical Education and Research (Albuquerque). W. R. Lovelace, II, *et al,* Indirect Blast Injuries.

Massachusetts Eye and Ear Infirmary (Howe Laboratory of Ophthalmology). D. G. Cogan and J. H. Kinoshita, A Study of the Metabolism of the Ocular Lens with the Use of Radioactive Compounds.

Massachusetts General Hospital. J. C. Aub, I. T. Nathanson and P. C. Zamecnik, A Biochemical Study of the Effects of Radiation on Cells.

Massachusetts General Hospital. Oliver Cope, Effects of Radioactive Iodine on Biology of the Thyroid Gland.

Massachusetts General Hospital. H. L. Hardy, Establishment of a Beryllium Case Registry.

Massachusetts General Hospital. J. B. Stanbury, The Metabolism of Calcium and Strontium as Disclosed by Tracer Studies on Patients with Thyroid and Related Diseases.

Massachusetts General Hospital. W. H. Sweet, Use of Thermal and Epithermal Neutrons in the Treatment of Neoplasms.

Massachusetts General Hospital. W. H. Sweet, External Localization of Brain Tumors Employing Positron-Emitting Isotopes.

Massachusetts Memorial Hospitals. Charles Emerson, Jr., Physiological and Therapeutic Investigations and Fundamental Blood Studies Using Radioactive Isotopes.

Meharry Medical College. Horace Goldie, Effect of X- and Beta Irradiation on Free Growth of Malignant Cells and on Organized Malignant Tumors, and Effect of Pretreatment with Biological and Chemical Agents.

Meharry Medical College. P. F. Hahn, Use of Radioactive Gold in Treatment of Tumors.

Miami Heart Institute (Coral Gables). N. L. Noble, The Influence of Certain Diets, Vitamins and Hormones Upon Cholesterol Synthesis and Heparin Concentration of Connective Tissues.

Miami, University of. E. L. Chambers, A Quantitative Study of the Effects of Radiation on the Blood Capillaries of Normal Animals.

Michigan, University of. R. L. Potter, H. J. Gomberg, *et al,* Hematological and Biochemical Effects of Ionizing Radiations.

Michigan, University of. F. J. Hodges and Isadore Lampe, Clinical Evaluation of Teletherapy.

Michigan, University of. W. J. Nungester, Immunological Study of Tumors.

Minnesota, University of. W. D. Armstrong and W. O. Caster, Effect of Ionizing Radiations upon Tissue Metabolism.

Minnesota, University of. L. A. French and S. N. Chou, Study of Mechanisms of Radioactive Isotopic Localization in Tissues of the Central Nervous System.

Minnesota, University of. J. F. Marvin, F. J. Lewis and C. W. Lillehei, Toxic Effects of Irradiation.

Minnesota, University of. Samuel Schwartz, Synthesis of Hemoglobin in Bone Marrow and Maturation and Multiplication of Blood Cells.

Minnesota, University of. C. J. Watson, Investigation of Porphyrin and Bile Pigment Metabolism.

Montefiore Hospital (Pittsburgh). Richard Abrams, Synthesis of Nucleic Acid Purines in Bone Marrow.

Montefiore Hospital for Chronic Diseases (New York City). Daniel Laszlo, A Study of the Distribution and Excretion of Lanthanum and the Rare Earth Elements.

Montefiore Hospital for Chronic Diseases (New York). Daniel Laszlo, Dynamics of Strontium Distribution in the Body.

Nebraska, University of. W. J. Arnold, Effects of Cranial X-Irradiation on Physiological Processes in Rats.

New England Center Hospital. William Dameshek, Physiopathology of Platelets and Development of Platelet Substitutes.

New England Deaconess Hospital (*Pondville Hospital*). S. P. Hicks, The Effects of Ionizing Radiation on the Developing Mammalian Nervous System.

New England Deaconess Hospital. Shields Warren, *et al.*, Acute and Chronic Radiation Injury.

New York, Research Foundation of the State University of. J. H. Ferguson and M. F. Hilfinger, Experimental Transfusion of Bone Marrow into Rabbits After Total Body Irradiation.

New York, Research Foundation of the State University of. Jack Gross, The Metabolism of Radioactive Thyroid Hormones in Tumor Bearing Animals and Tumor Tissue.

New York, State University of, Upstate Medical Center. Alfred Farah, Changes in Protein-Bound Sulfhydryl in Renal Cells Under Varying Experimental Conditions.

New York University, Bellevue Medical Center. J. M. Converse, (a) The Effect of the Degree and Duration of Refrigeration on Human and Animal Skin; (b) The Search for Antibodies Produced by the Application of Skin Homografts in Animals and Man.

New York University, Bellevue Medical Center. J. M. Converse, The Transfer of Cellular Antibodies in Relation to the Immunological Aspects of the Homograft Rejection Reaction.

New York University. Norton Nelson, Aerosol Retention Studies.

New York University, Bellevue Medical Center. Norton Nelson, Immunochemical Studies on Beryllium.

New York University, Bellevue Medical Center. W. E Smith, Investigation of Factors which may Modify Neoplastic Changes Induced by Irradiation.

New York University, Bellevue Medical Center. M. B. Sulzberger, Study of the Biological Effects of Ionizing Radiation (Alpha and Beta) on Human Skin.

New York University, College of Medicine. H. W. Smith, Body Fluid and Electrolyte Distribution and Collateral Physiological Studies.

North Carolina, University of. B. G. Stall, III, A Study of Ion Transport Across Smooth Muscle Cell Membrane.

North Carolina, University of. C. D. Van Cleave, The Double Isotope Effect of Ca–45 and Sr–89 on the Pattern of Distribution in the Body, Particularly in Bone.

Northwestern University. Loyal Davis, Further Development and Utilization of Radioactive Dyes in the Diagnosis and Localization of Brain Tumors.

Northwestern University, Medical School. D. P. Earle, The Effects of Irradiation on Renal Transport Systems.

Oklahoma Medical Research Foundation. L. P. Eliel, Characterization of Changes in the Growth Rate of Human Neoplasms Using Radioactive Isotopes.

Oklahoma Medical Research Institute and Hospital. C. D. Kochakian, Metabolism of Radioactive Sex Hormones.

Oklahoma Medical Research Foundation. C. D. Kochakian, Androgen Regulation of the Incorporation of Radioactively Labeled Amino Acids into Tissues.

Oregon, University of, Medical School. E. E. Osgood and A. J. Seaman, Studies of Hemic Effects of Radioisotopes, X-Rays and of Adrenocortical Hormones.

Oregon Medical School, University of. J. T. Van Bruggen, Studies on Lipogenesis.

Parke, Davis and Company (Detroit). J. K. Weston, Factors Elaborated by Animal Tissues which Stimulate Rate of Regeneration of Hematopoietic Organs of Animals Exposed to Total Body Irradiation with Gamma Rays.

Pennsylvania, University of. T. F. Anderson, Biophysical Studies of Bacteriophages and Their Synthesis.

Pennsylvania, University of. G. M. Austin and F. C. Grant, An Investigation of the Use of Na–24 in Cerebral Edema, Brain Tumors, and Focal Epileptic Lesions.

Pennsylvania, University of. H. L. Conn, Kinetics and Mechanisms of Ion Transfer in the Heart.

Peter Bent Brigham Hospital. F. D. Moore, Intracellular Changes in Trauma, Depletion and Repair; Biochemical Studies on the Human Being with the Aid of Isotopes.

Pittsburgh, University of. L. V. Beck, Attempted Modification of Mammalian Tumor Radiosensitivity with Agents and Procedures Altering Host Sensitivity.

Pittsburgh, University of. F. S. Cheever, The Effect of Ionizing Radiation on the Virus-Host Cell Relationship.

Pittsburgh, University of, School of Medicine. T. S. Danowski, Neoplasia and the Disposal of Exogenous Thyroxin.

Pittsburgh, University of, School of Medicine. F. J. Dixon, The Study of the Effects of Radiation on the Immune Response.

The Retina Foundation (Boston). M. A. Jakus, A Comparison of the Fine Structure of the Normal and the Irradiated Lens.

Rheumatic Fever Research Institute (Chicago). R. W. Schayer, Metabolism of Biologically Active Amines.

Rochester, University of. G. B. Forbes, Metabolism of Bone Sodium.

Rochester, University of, School of Medicine and Dentistry. L. H. Hemplemann, Individual Response to Ionizing Radiation in Animals and Patients.

The Saranac Laboratory (Saranac Lake). G. W. H. Schepers, Studies on the Experimental Pathology and Biochemistry of Pulmonary Granulomatosis.

Seton Hall University (South Orange, N. J.). E. V. Brown, Metabolism of a New Carcinogen Using Radioactive Carbon.

Sloan Kettering Institute for Cancer Research, Memorial Hospital. C. P. Rhoads, Biological Effects of Radiation, and Related Biochemical and Physical Studies.

Southern California, University of, School of Medicine. W. E. Goodwin, Intracavitary Application of Beta Sources.

Southern California, University of. Eloise Jameson, Electrophoretic Studies on X-Irradiated Rats on High Fat and Fat Deficient Diets.

Southern California, University of. P. D. Saltman and E. M. Butt, The Mechanism of Ion Secretion.

Southwest Foundation for Research and Education (San Antonio). N. T. Werthessen, Investigation of *in vitro* Organ Maintenance Technique for Production and Isolation of Post-Irradiation Recovery Factors.

Southwestern Medical School (Austin). W. W. Burr, D. S. Wiggans and H. W. Rumsfeld, Jr., The Metabolism of Doubly Labeled Serum Albumin.

St. Louis University. Henry Pinkerton, Study of the Relation of Rickettsial and Viral Infections to Radiation Injury.

St. Luke's Hospital (New York). E. H. Reisner, Jr., The Life Span and Behavior of Mammalian Platelets *in vitro* and *in vivo* Using Chromium 51 Tag.

Stanford University. H. S. Kaplan and E. L. Ginzton, Biological and Medical Investigations with the 70 Mev Linear Electron Accelerator.

Tennessee, University of. N. R. DiLuzio, The Response of the Reticulo-Endothelial System to X-Irradiation.

Tennessee, University of. Aaron Ganz, Factors Influencing the Distribution of Intravenously Administered Radiogold Colloids.

Tennessee, University of. W. M. Hale, A Study of the Effects of Cobalt 60 Gamma Irradiation on Infection and Immunity.

Tennessee, University of. R. E. Koeppe, The Metabolism of Serine in the Intact Rat.

Tennessee, University of. R. R. Overman, Physiology of Water and Ionic Balance in Monkeys Subjected to Whole Body Radiation.

Tennessee, University of. R. R. Overman, Mechanisms of Ionic Imbalance and Pathophysiologic States.

Tennessee, University of. J. D. Perkinson, Jr., Effect of Internal Irradiation on Cellular Metabolism.

Tennessee, University of. Lester Van Middlesworth, Thyroid Metabolism and Methionine Metabolism; Determination of Radioactivity in Thyroid Glands from Different Parts of the World.

Tennessee, University of. J. L. Wood, The Origin and Fate of Thiocyanate Ion in Metabolism.

Texas Technological College. S. J. Kaplan, The Effects on Rat Behavior of Developmental Aberrations Induced by Ionizing Radiation *in utero.*

Tufts College. David Rapport, Study of the Effects of Radiation on Growth.

Tufts College. Richard Wagner, Enzyme Studies on White Blood Cells and Blood Platelets.

Tulane University of Louisiana. R. H. Turner, The Influence of Radiation Injury upon Physiology of Serum Lipids with Particular Reference to the Function of the Liver.

Tulane University of Louisiana. W. S. Wilde, The Metabolic Exchange of Tissue Electrolytes.

Utah, University of. S. R. Dickman, The Pathways of Glucose Oxidation in the Pancreas.

Utah, University of. M. M. Wintrobe and G. E. Cartwright, Metabolism of Trace Elements in Animals and Man with Special Reference to Their Role in Erythropoiesis.

Vanderbilt University, School of Medicine. M. T. Bush, Metabolic Fate of Barbituric Acid Anesthetics with Special Reference to Evipal.

Vanderbilt University, School of Medicine. W. J. Darby, Study of the Absorption and Metabolism of Lipids and Vitamins and the Alterations which Occur in Acute Radiation Injury.

Virginia Medical School, University of. C. L. Gemmill, The Metabolic Exchange of Radioactive Isotopes in Isolated Cell Systems.

Virginia, Medical College of. H. G. Kupfer and N. F. Young, An Investigation of Certain Tissue Protein Changes in Irradiated Animals.

Wake Forest College, Bowman Gray School of Medicine. Camillo Artom, Formation of Tissue Phospholipides and Toxicity of P–32 as Related to Dietary Factors.

Wally Bohannon, Hodgkin's Research Foundation, (Houston). J. M. Rose, Radioisotope Studies in Hodgkin's Disease.

Washington University (St. Louis). David Lipkin, Synthesis of Nucleotides and Related Compounds.

Washington University (St. Louis). I. L. Shechmeister, Investigations of the Relationship Between Radiation Damage and the Immune State.

Washington, University of (Seattle). C. A. Finch, Erythropoiesis and Iron Metabolism.

Washington, University of (Seattle). B. W. Gabrio and F. M. Huennekens, Enzymatic Components and Physiological Function in the Erythrocyte.

Washington, University of (Seattle). R. L. Huff, Hemodynamics; Blood Dynamics as Measured by Simultaneous Multiple Port Scintillation Detection of I–131 Human Serum Albumin.

Washington, University of (Seattle). R. D. Ray, Mobilization of Radioactive Emitters from Bone.

Washington, University of (Seattle). R. H. Williams and H. H. Tomizawa, Studies of Isotopically Labeled Hormones.

Wayne University College of Medicine (Detroit). J. E. Lofstrom, Evaluation of Radioactive Isotope Gamma Ray Source for Medical Teletherapy.

Western Reserve University, School of Medicine. B. M. Dobyns, A Study of the Physiological Function and Histological Changes of Thyroids Irradiated with Radioactive Iodine.

Western Reserve University. H. L. Friedell, Investigations of the Biological Effects of Internally Deposited Radioisotopes and Related Radiobiology Studies.

Western Reserve University. L. O. Krampitz, Synthesis of Nucleic Acids by *Escherichia coli* and Bacteriophage Systems.

Western Reserve University. O. A. Ross, An Investigation of A Recently Isolated Serum Factor (Properdin) in Relation to Its Role in Protecting Against Early Death Following Exposure to Ionizing Radiation.

Western Reserve University. H. G. Wood, A Study of Intermediary Metabolism with Isotopically Labeled Compounds in Perfused Organs, Whole Animals, and Humans.

West Virginia University, School of Medicine. R. F. Krause, Investigation into the Uptake of P–32 by the Tissues of the Rat as Influenced by Carotene-Vitamin A Metabolism.

Wisconsin, University of. H. F. Harlow and P. H. Settlage, The Effect of Various Forms of Irradiation of the Brain on Learned and Unlearned Behavior of Monkeys and Chimpanzees.

Worcester Foundation for Experimental Biology. Gregory Pincus, Investigation of the Effects of Radiation on the Biosynthesis and Metabolism of Adrenocortical Steroids.

Yale University. C. E. Carter, Phosphorylation Mechanisms in Nucleic Acid Synthesis in Hematopoietic Tissue.

Yale University. S. R. Lipsky, The Formation and Utilization of the Saturated and "Essential" Fatty Acids in the Biosynthesis of Various Lipids in Man.

Yerkes Laboratory of Primate Biology, Inc., (Orange Park, Fla.). H. W. Nissen, Behavioral Effects of Ionizing Radiation on Chimpanzees of Various Ages.

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Radiation Instrumentation

Airborne Instruments Laboratory (Mineola, Long Island, N. Y.). K. C. Speh, Automatic Scanning of Nuclear Emulsions.

Armour Research Foundation of the Illinois Institute of Technology. Leonard Reiffel, Detection of Airborne Beryllium Dust.

Commerce, U. S. Department of, National Bureau of Standards. Evaluation and Testing of Radiation Instruments.

Commerce, U. S. Department of, National Bureau of Standards. Louis Costrell, Radiation Monitoring Telemetering System.

Commerce, U. S. Department of, National Bureau of Standards. W. A. Wildhack, Basic Instrumentation Program.

Leventhal Electronic Products, Inc. (Redwood City, Calif.). W. J. Van Sciver, Study of Scintillation and Other Related Properties of NaI Crystals.

Louisville, University of. R. H. Wiley, Synthesis and Properties of Organic Scintillators.

Naval Research Laboratory. J. H. Schulman, Research on Dosimetric Problems Emphasizing Studies in the Megaroentgen Range (Dosimetry Systems Employing Radiation Sensitive Solids).

New England Center Hospital, Pratt Diagnostic Clinic. C. V. Robinson, Small GM and Proportional Counters for Medical Research.

New York University, Washington Square College. M. H. Shamos and S. Z. Lewin, Investigation of Certain Physical and Chemical Dosimetric Techniques.

Notre Dame, University of. E. A. Coomes, Fundamental Research on Photoemission.

Radio Corporation of America (Harrison, N. J.). Multiplier Phototube Development.

St. Procopius College (Lisle, Ill.). F. R. Shonka, Special Problems in Nuclear Instrumentation.

RAW MATERIALS RESEARCH CONTRACTS

Battelle Memorial Institute. Frank Stephens, Ammonium Carbonate Leaching.

Colorado School of Mines Research Foundation. Fred L. Smith, Determination of Physical and Other Properties of Rock Samples.

Colorado School of Mines Research Foundation. Fred L. Smith, Determine Solvent or Precipitation Reaction of Sufficient Magnitude to Effect Localization of Uranium Deposits.

Columbia University. W. H. Bucher, Geologic Study of Uranium-Bearing Precambrian Dripping Spring Quartzite, Gila County, Ariz. and Adjacent Areas.

Columbia University. H. D. Hassialis, Recovery of Uranium from the Chattanooga Shale.

Columbia University. Paul F. Kerr, Alteration Studies of Uranium Deposition at Temple Mountain and on the San Rafael Swell.

Johns Hopkins University. Aaron Waters,[2] The Geology of Uranium in Tuffaceous Lake Beds of the Western United States.

Little, Arthur D. Raymond Byler, Development Studies and Chemical Investigation of New Techniques for Recovery of Uranium.

Minnesota, University of. J. W. Gruner, Mineralogic and Petrographic Nature and Genesis of Uranium Ores in the Black Hills Area.

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[2] Contract with Dr. Waters personally.

Nevada, University of. V. E. Scheid, Development Studies on the Beneficiation of Uranium Ores, and Extractive Metallurgy for Recovery of Uranium from Ores.

Pennsylvania State University. D. R. Mitchell and H. B. Charmbury, Concentration of Uranium and Other Values from Phosphatic Materials by Dry Methods of Beneficiation.

Pennsylvania State University. Harold Wright, Research on Trace Quantities of Uranium in Sulfides of Veins.

Princeton University. H. D. Holland, Investigation of Known Uranium Ore Bodies in Dry Valley, Utah and Other Areas to Delineate Geochemical Halos.

Utah, University of. W. M. Fassell, Jr. and M. E. Wadsworth, Kinetics of Leaching of Uranium Minerals.

REACTOR DEVELOPMENT RESEARCH CONTRACTS

Aeroprojects, Inc. J. B. Jones, Effect of Ultrasonic Energy on Beryllium Solidification.

Aeroprojects, Inc. W. C. Pothoff, Application of Ultrasonics to Liquid-Liquid Extraction.

Arcos Corp. R. D. Thomas, Jr., Welding of Type 347 Stainless Steel.

California, University of. Dr. H. A. Johnson, Research on Metallurgical Investigations and Heat Transfer.

California, University of. Dr. W. J. Kaufman and Dr. Gerhard Klein, Disposal of Radioactive Wastes into the Ground.

Chicago, University of. Dr. L. S. Skaggs, Utilization of Fission Products.

Columbia University. Charles F. Bonilla, Boiling and Condensing of Liquid Metals.

Harvard University. Prof. H. A. Thomas, Jr., Disposal of Radioactive Waste into Surface Waters.

Harvard University. Dr. Leslie Silverman, Air Cleaning Research and Development.

Illinois, University of. Dr. H. F. Johnstone, Investigation of Fundamental Properties of Aerosols as Related to Air Cleaning.

Johns Hopkins University. Dr. Walter A. Patrick, Separation and Fixation of Specific Isotopes from Radioactive Wastes.

Johns Hopkins University. Dr. Charles E. Renn, Ultimate Disposal of Radioactive Wastes to the Natural Environment.

Massachusetts Institute of Technology. Dr. Rolf Eliassen, Decontamination of Low-Level Radioactive Wastes by Sanitary Engineering Processes.

Michigan, University of. Dr. L. E. Brownell, Industrial Utiliziation of Fission Products.

National Academy of Sciences. Drs. R. J. Russell and W. Thurston, Disposal of Radioactive Wastes into Surface and Subsurface Geologic Structures.

National Bureau of Standards. Franz Alt, Shielding Calculations. Detailed calculations of gamma ray attenuation in various media, covering a wide range of gamma energies.

Northwestern University. Dr. Carlos G. Bell, Study of Waste Disposal Dilution Factors in the Des Plaines River and Chicago Drainage Canal.

Nuclear Development Associates, Inc. Dr. Herbert Goldstein, Shielding Studies.

Pennsylvania State University. Prof. Joseph Marin, Stresses at Nozzle Connections of Pressure Vessels.

Rensselaer Polytechnic Institute. Prof. Paul Harteck, Operation of a Modified Distillation-Diffusion Apparatus in the Separation of Isotopes of Metals and a Study of the Reaction Rates of Gases Under Pile Irradiation.

Texas, University of. Dr. E. Gloyna, Disposal of Low-Level Radioactive Wastes by Algae Concentration. Studies of practicality of handling low-level wastes through concentration capacities of algae.

Yale University. Prof. R. H. Bretton, Research on Effect of Radiations From Fission Products, Particularly Gamma Radiation on Chemical Reactions.

U. S. Bureau of Mines. R. C. Corey, Incineration of Radioactive Wastes. To develop a practical incinerator for disposal of solid combustible radioactive wastes.

U. S. Weather Bureau. H. A. Thomas, Jr., Research on the Dispersal of Atmospheric Wastes Which May Be of Practical Use in the Location, Design, and Operation of Nuclear Energy Facilities.

Appendix 8
AEC Financial Report for Fiscal Year 1955

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D.C.

November 1, 1955

MEMORANDUM TO THE COMMISSIONERS:

Submitted herewith is the unclassified financial report of the Atomic Energy Commission for fiscal year 1955. It contains financial statements which set forth the financial position of AEC at June 30, 1955, the results of operations for fiscal year 1955, and other information of general use to the Commission.

A supplemental report prepared for limited distribution contains production and unit cost data, a balance sheet showing stockpile inventories, and other classified information.

Don S. Burrows
Controller

INTRODUCTION

From 1940 through 1955, $12.2 billion has been spent by the AEC and predecessor organizations for the atomic energy program. A major portion of the amount spent is invested in facilities, raw materials, and products. At June 30, 1955, the investment in plant and equipment amounted to $6.5 billion. A substantial part of the materials and products can be used for peaceful as well as military purposes. For security reasons inventories of stockpiled products are not shown in this report.

Since AEC operations are essentially industrial in character, the need to gather, summarize, and interpret cost and financial information on a systematic and continuous basis is in many ways similar to that experienced by private enterprise. Production operations are conducted through contracts with leading industrial firms, and a major portion of the research is conducted through contracts with commercial concerns and universities. For purposes of financial control and for providing cost data, major contractors establish cost and accounting systems for AEC operations which are entirely separate from their other activities and are an integral part of AEC records. This method of financial control and integration of records eliminates duplication of effort, facilitates funding of contractor operations, aids in the preparation of financial and unit cost reports, and establishes the contractors' financial responsibility to AEC for funds and property.

Accounts are maintained in accordance with AEC policies and standards based on generally accepted commercial accounting principles. Consequently, revenues are recorded when earned and expenses are recognized when goods or services are used. Depreciation of assets based on the useful life of facilities is computed and assigned to operations in order to show more accurately the full cost of products, activities, and inventories. Assurance that all AEC installations observe established financial policies and standards is obtained through the AEC audit program. Periodic examinations of policies, procedures, and records are made to determine that accounting, cost reporting, and financial control are functioning effectively and economically.

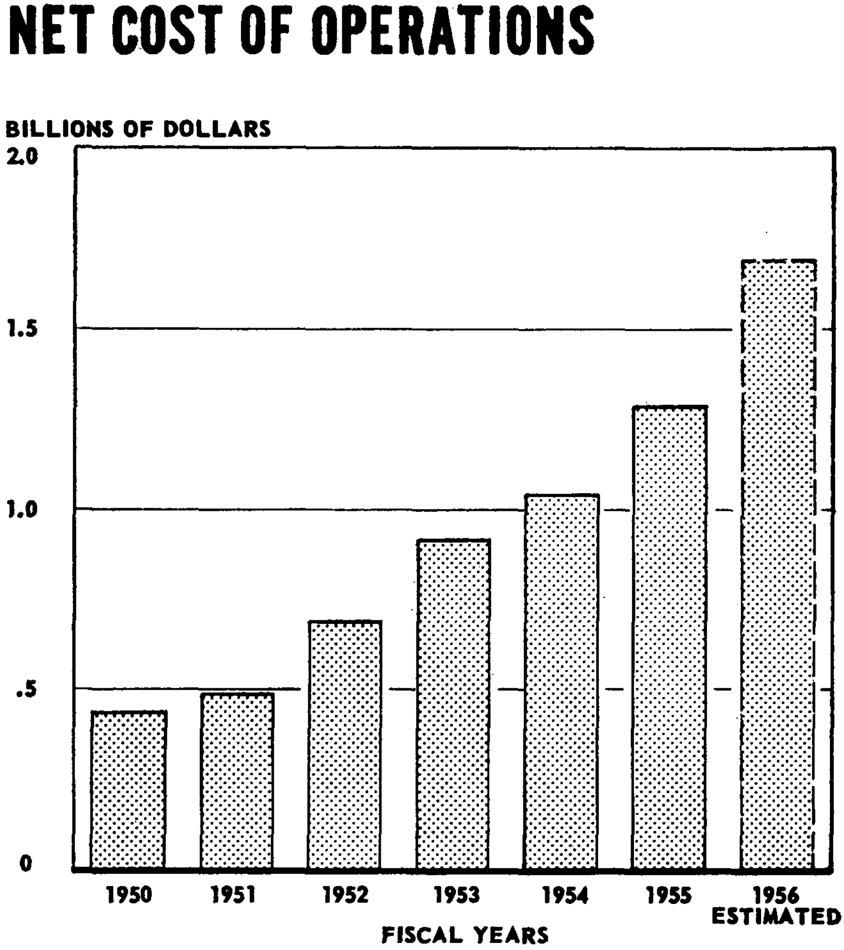
HIGHLIGHTS—FISCAL YEAR 1955

	1955	*1954*
	(In millions)	
OPERATIONS ADVANCED TO THE HIGHEST LEVEL IN AEC HISTORY:		
The procurement of raw materials and production of enriched uranium, plutonium, and other nuclear products increased—Total cost increased 42% over 1954	$785	$552
Reactor development for civilian power increased 30%—Naval, aircraft, and other reactor development increased 13%	118	100
Weapons design, development, fabrication, storage, and full-scale tests increased 4%	260	251
Biology and medicine and physical research increased 5%	76	73
Net cost of operations increased 24%	1,290	1,039
PLANT AND EQUIPMENT IN USE REACHED A NEW HIGH:		
Completed facilities for use in research and development and for the production of feed materials, enriched uranium, plutonium, and other products increased 43%	$5,858	$4,090
MAJOR PLANT EXPANSION NEARS COMPLETION:		
Completion of large projects resulted in a 31% decrease in construction costs	$842	$1,215
Construction work in progress decreased 61%	629	1,615
Estimated cost of completing new facilities now under construction	600	

OPERATIONS

NET COST OF OPERATIONS INCREASED 24% TO $1.3 BILLION

The extent of the increase in operating costs in fiscal year 1955 and prior years, and estimated costs for fiscal year 1956 are shown in the chart below. This increase in cost of operations is largely the result of increased purchases of raw materials and of putting new production and research facilities into operation. The need for additional production and research was recognized several years ago as the increasing importance of atomic energy to our national welfare—civilian as well as military—became apparent.



Costs of each operating program, including depreciation, are shown in the following table for the fiscal years 1950 through 1955.

OPERATING COSTS

(Including Depreciation)

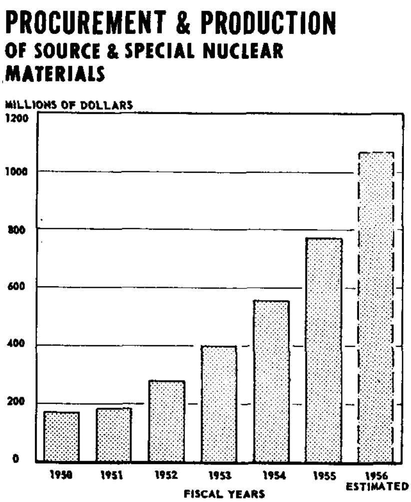
For the years 1950 through 1955

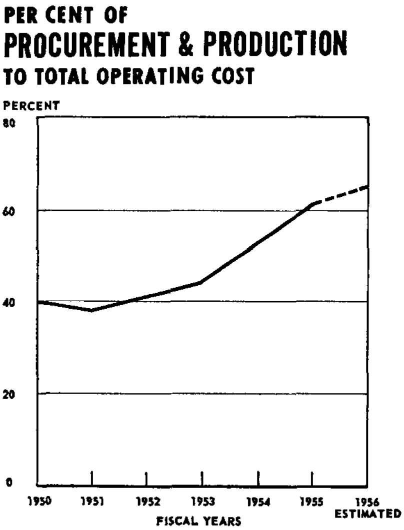
	1950	*1951*	*1952*	*1953*	*1954*	*1955*
			(In millions)			
Source and special nuclear materials	$168	$188	$278	$400	$552	$785
Weapons	112	164	229	258	251	260
Reactor development	32	44	65	105	100	118
Physical research	33	34	38	44	45	47
Biology and medicine	20	23	26	27	28	30
Community	20	17	16	15	12	10
Administration	23	25	32	35	35	34
Security investigations [1]	—	—	1	13	12	10
Other (net)	7	—	(1)	7	4	(4)
NET COST OF OPERATIONS	$415	$495	$684	$904	$1, 039	$1, 290

[1] Security investigation costs prior to 1952 were paid from appropriations to the Federal Bureau of Investigation. In fiscal year 1952 $1.3 million was provided from appropriations to AEC and $12.1 million from appropriations to the FBI.

SOURCE AND SPECIAL NUCLEAR MATERIALS PROCUREMENT AND PRODUCTION COSTS INCREASED 42% TO $785 MILLION

The chart at the left shows the increase in total cost of source and special nuclear materials over the past several years. In 1955 these costs, including depreciation, amounted to $785 million or 42% more than in 1954. They include the exploration for and procurement of





uranium ores and concentrates, the development and improvement of processes for the refinement of uranium, the extraction of the isotope uranium 235 in gaseous diffusion plants, and the production of plutonium and other materials.

The chart at the right on the preceeding page shows the percent of AEC operating costs applicable to procurement and production of source and special nuclear materials.

Increased purchases of uranium concentrates from domestic and foreign sources and the operation of new facilities for the production of special nuclear materials were the primary causes of the rise of 370% since 1950 in the cost of this program. A large portion of these costs have been to acquire inventories which can be made available for peaceful as well as military purposes. Inventories of production work in process rose $254 million during fiscal year 1955 to $1.1 billion. This inventory does not include stockpiled products.

WEAPONS PROGRAM COSTS INCREASED 4% TO $260 MILLION

The cost of manufacturing atomic weapons, the development, design, and testing of new weapon types, and the maintenance of stockpiled products in a state of constant readiness increased to $260 million in 1955 from $251 million in 1954. These amounts exclude the cost of source and special nuclear materials contained in weapons components or consumed in weapons research and tests. During the fiscal year 1955, full-scale tests were conducted at the Nevada Test Site. In fiscal year 1954 full-scale tests were conducted at the Eniwetok Proving Ground.

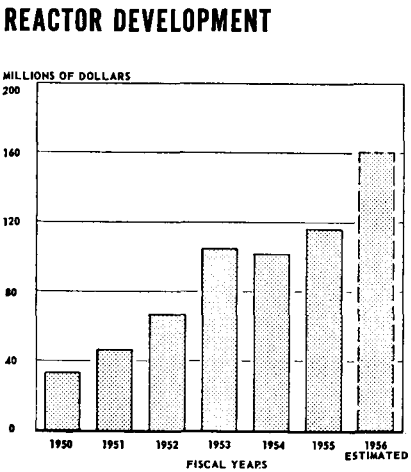
REACTOR DEVELOPMENT COSTS INCREASED 18% TO $118 MILLION

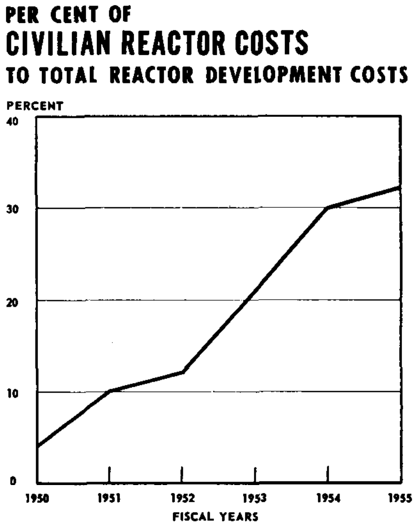
The chart at the left on the next page shows the increase during the past 6 years in costs of developing reactors for civilian and military use, and estimated costs for 1956. In 1955 these costs totaled $118 million or 18% more than in 1954. They include costs of research, engineering, design, and development of reactors to propel Naval vessels and aircraft, to meet military needs for heat and power in remote areas, and to produce power for civilian uses.

A pressurized water reactor is now being constructed at Shippingport, Pa. This will be the first United States full-scale nuclear central station powerplant. The Duquesne Power and Light Company is constructing the electric generating facilities and contributing toward the construction of the reactor portion of the plant.

During the fiscal year 1955, AEC established a Power Demonstration Reactor Program planned to encourage industry to develop, construct, and operate experimental nuclear power reactors. The aim of this program is to bring private resources into the development of engineering information on the performance of nuclear power reactors and thus advance the time when nuclear power will become economically competitive. At June 30, 1955, AEC had under consideration four proposals from private organizations for development and construction of facilities for production of electric power with nuclear energy. Taking the proposals as a group the estimated capital cost of the four plans would be about $150 million of which 80 to 90% would be borne by the proposers.

The chart at the right shows the increase in the percent of the





costs of reactor development directly related to civilian use. Although the chart indicates a specific amount as applicable to civilian use, knowledge gained in research on military reactors is also useful for civilian application.

In 1955 work on specific reactor designs constituted 82% of the scientific and technical effort in the reactor development program. The costs of the five-year civilian power development program increased nearly 40% over 1954. The types of reactors included in the five-year program are shown in the table on the next page together with costs of other civilian and military reactor development and construction. The development and construction of reactors for the submarines "*Nautilus*" and "*Sea Wolf*" are included under "Naval propulsion" in this table.

In developing reactors for military use and for civilian power, the cost of construction of reactors, experimental models and related facilities is closely allied to "development" costs. For this reason, the cost of construction of assets applicable to this program are shown along with the development costs in the table below.

REACTOR DEVELOPMENT AND CONSTRUCTION

	Development 1955	Development 1954	Construction 1955	Construction 1954
	(In millions)			
Civilian power reactors:				
Five-year plan:				
Pressurized Water Reactor	$ 10. 2	$ 7. 7	$ 1. 2	—
Boiling Water Reactor	4. 0	2. 4	. 1	—
Sodium-Graphite Reactor	1. 9	1. 5	—	—
Fast Breeder Reactor	3. 5	3. 4	—	—
Homogeneous Reactor	6. 7	3. 9	. 2	—
	26. 3	18. 9	1. 5	—
Other	6. 3	6. 3	—	$0. 4
TOTAL CIVILIAN	32. 6	25. 2	1. 5	. 4
Naval propulsion reactors	26. 8	24. 9	12. 9	24. 1
Aircraft reactors	22. 6	14. 6	3. 3	7. 4
Army package power reactors	. 6	—	—	—
Operating service facilities	5. 4	7. 8	5. 7	2. 3
General	12. 6	12. 4	7. 6	3. 7
	100. 6	84. 9	31. 0	37. 9
Depreciation of facilities	17. 4	15. 2	—	—
TOTAL	$118. 0	$100. 1	$31. 0	$37. 9

To further encourage the interest of private enterprise in civilian uses of atomic energy, AEC began issuing permits for access to confidential information to those applicants who could evidence a potential use or application of the information in their business, profession or trade. Access to certain specific secret information is also granted if the applicant can demonstrate that such information has an immediate or significant effect on his business, profession, or trade. Applicants for permits must obtain appropriate security clearances and agree to pay established charges for publications and other services furnished by AEC.

From the time the access program was announced in April 1955 to June 30, 1955, 214 applications for permits were received. At the end of the fiscal year 148 of the applications had been approved and the remainder were in process of being reviewed. In 1955, AEC also established prices and charges for the sale or lease of source and nuclear materials and issued licenses for 2,900 pounds of normal and depleted uranium and 110 pounds of thorium.

PHYSICAL RESEARCH COSTS INCREASED 3.3% TO $46.5 MILLION

Physical research is carried on by the AEC for the purpose of assuring the Government adequate scientific and technical accomplishment in the field of atomic energy. Every advance in atomic capability can be traced back to laboratory research of the type now carried on under this program. The aim is to develop and mobilize adequate scientific talent and facilities for work on the most urgent and promising problems of atomic energy. About 70% of the research is done in the Commission's own laboratories. The remaining 30% is done in facilities provided by educational institutions and private organizations.

Physical research costs increased to $46.5 million in 1955 from $44.9 million in 1954 or 3.3%. The following table shows the cost of the major types of research for 1955.

PHYSICAL RESEARCH COSTS

	Fiscal Year 1955 (in thousands)
Physics research:	
High energy physics	$7,722
Nuclear structure and neutron physics	8,835
Extra-nuclear properties of matter	1,435
Design and development of devices for physics research	841
Physical methods of isotope separation	390
TOTAL	19,223
Chemistry research:	
Process chemistry	5,004
Chemical properties and reactions	8,793
Chemical isotope separation	554
Other	746
TOTAL	15,097
Metallurgy and materials research:	
Production, treatment and properties of materials	2,273
Alloy theory and the nature of solids	1,397
Effects of irradiation on materials	870
TOTAL	4,540
Radioactive and stable isotopes	2,011
University cooperation and training	200
	41,071
Depreciation of facilities	5,431
TOTAL PHYSICAL RESEARCH	$46,502

BIOLOGY AND MEDICINE RESEARCH COSTS INCREASED 8% TO $29.7 MILLION

The development and use of atomic energy have raised many questions concerning the radiation effects—beneficial and harmful—on men, animals, and plants. In order to combat harmful effects one must first know what they are. Similarly, the development and utilization of beneficial applications of atomic energy in the life

BIOLOGY AND MEDICINE RESEARCH COSTS

	Fiscal Year 1955 (In thousands)
Radiation effects on biological systems:	
Cancer research	$77
Medical research	2,473
Biological research	6,062
Biophysics research	209
TOTAL	8,821
Combating radiation detrimental effects:	
Medical research	1,009
Biological research	774
Biophysics research	202
TOTAL	1,985
Beneficial applications of atomic energy:	
Cancer research	1,789
Medical research	3,389
Biological research	2,759
Biophysics research	19
Distribution of isotopes for cancer research	244
TOTAL	8,200
Biomedical problems in atomic energy operations:	
Medical research	720
Biological research	1,862
Biophysics research	2,500
TOTAL	5,082
Dosimetry and instrumentation	2,287
Vocational and special training	439
	26,814
Depreciation of facilities	2,888
TOTAL BIOLOGY AND MEDICINE RESEARCH	$29,702

sciences is of primary importance. Both areas are being systematically investigated in the AEC Biology and Medicine Research Program.

Biology and medicine costs increased to $29.7 million in 1955 from $27.7 million in 1954, or 8%. The preceding table shows the cost of the major categories of research in 1955. In this table "Medical" includes studies of AEC problems relating to the care, treatment and understanding of human physiology and disease. "Biological" includes studies of the immediate and long-range effects of radiation on plants and animals. "Biophysics" involves studies to determine the amount of radiation which can be harmful to human beings and methods of keeping the amount below that point in food, air, water and general environment. It also includes costs of designing and testing nuclear detection instruments, as well as studies related to waste disposal problems.

NET COST OF COMMUNITY OPERATIONS DECREASED 12% TO $10.4 MILLION

Because of the isolation of some of the major atomic energy facilities from population centers, it was necessary to establish communities during World War II in which both government and contractor personnel could live. Entire communities were built including houses, streets, schools, business buildings, and utility systems at a total cost of almost $300 million.

To facilitate establishment of local government at Oak Ridge, Tenn., and Richland, Wash., Congress, in 1955, authorized AEC to sell the houses, apartments, and business buildings to occupants or other interested persons. The Act also provides for transferring the municipal facilities and utilities to the new city governments or for selling them to other organizations. Cost of these community facilities less accumulated depreciation amounted to $150 million at June 30, 1955.

Community operations include four major activities: (1) municipal government which provides such services as schools, police and fire protection, street and road maintenance, and public health and sanitation; (2) utility operations, including water, electricity, gas, steam, transportation, and communications facilities; (3) real estate, which involves the maintenance and administration of family housing and dormitory units, leasing of concessions and direct commercial activities; and (4) the operation of hospitals. The following table shows the results of operations of the various communities for fiscal year 1955.

369460—56——13

COMMUNITY OPERATIONS FOR THE YEAR ENDED JUNE 30, 1955

By Community

Summary	*Total*	*Oak Ridge*	*Richland* (*In millions*)	*Los Alamos*	*Other*
Expenses:					
Depreciation	$13. 3	$5. 1	$3. 6	$4. 2	$0. 4
All other	18. 7	8. 8	5. 6	4. 0	. 3
Total expenses	32. 0	13. 9	9. 2	8. 2	. 7
Deduct:					
Revenue	21. 6	10. 1	6. 7	4. 3	. 5
NET COST	$10. 4	$3. 8	$2. 5	$3. 9	$0. 2
Major Activities					
Municipal	$10. 9	$5. 1	$3. 3	$2. 3	$0. 2
Real estate (net revenue)	(1. 1)	(1. 2)	(. 9)	1. 0	—
Utilities (net revenue)	(. 2)	(. 3)	(. 2)	. 3	—
Hospital	. 8	. 2	. 3	. 3	—
NET COST AS ABOVE	$10. 4	$3. 8	$2. 5	$3. 9	$0. 2

AEC ADMINISTRATIVE EXPENSES DECREASED 2% TO $34 MILLION

The direct AEC costs of general management, executive direction, and technical supervision of operations, negotiation and administration of contracts, and supporting administrative services, totaled $34.0 million during 1955, as compared with $34.6 million during 1954.

Administrative expenses compared to the total cost of operations continued to decrease. They amounted to 2.6% of operating costs during 1955 as compared to 3.4% in 1954, 3.9% in 1953, and 4.7% in 1952.

Administrative expenses for 1955 and 1954 were as follows:

	Fiscal Year 1955 (*In millions*)	*Fiscal Year 1954*
Salaries	$26. 1	$27. 2
Travel	1. 4	1. 3
Communications, supplies and other	5. 5	5. 1
Depreciation	1. 0	1. 0
	$34. 0	$34. 6

COSTS OF SECURITY INVESTIGATIONS DECREASED 22% TO $9.8 MILLION

Total cost of making security investigations in 1955 was $9.8 million, or $2.8 million less than the 1954 cost of $12.6 million.

The decrease can be attributed to two factors. First, the total number of full-background investigations for employee clearances decreased from 58,618 in 1954 to 44,918 in 1955. Second, the Commission established a new type of clearance for certain contractor employees and others who handle only material of a low order of sensitivity. The new type of clearances cost only 2% as much as those for employees who need access to highly classified information.

A smaller total number of clearances was possible because of the diminishing construction activity with its characteristically high rate of personnel turnover.

OTHER EXPENSES TOTALED $2.2 MILLION

The principal items comprising other expenses in 1955 are $1.1 million for abandoned construction projects, $0.8 million for materials, displays and printed matter used at the Geneva conference, and $0.3 million for miscellaneous other expenses.

OTHER INCOME TOTALED $5.7 MILLION

Income from operation of communities and reimbursement for work performed for others is applied as a reduction of costs. In fiscal year 1955 income from other sources was as follows:

	Amount (In thousands)
Sale of isotopes	$1,692
Sale of materials	997
Royalties from leased mines	702
Income from collateral funds	540
Donations	512
Fees from loan guarantees	351
Renegotiation refund receipts	255
Equipment rental	153
Miscellaneous	481
TOTAL	$5,683

Plant

and

Equipment

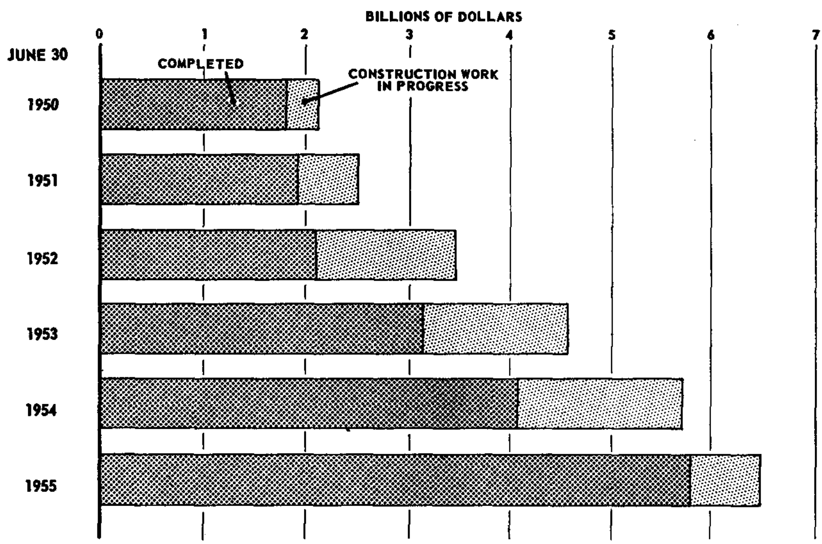
369460—56——14

COMPLETED PLANT AND EQUIPMENT INCREASED 43% IN 1955

In fiscal year 1955, more new atomic energy facilities were completed by AEC than in any prior year. Completed plant and equipment increased to $5.9 billion at June 30, 1955 from $4.1 billion at June 30, 1954 or 43%. Construction work in progress amounted to $629 million at June 30, 1955, bringing the total AEC investment in plant and equipment to $6.5 billion. When construction now authorized is completed, AEC plant and equipment will total approximately $7.5 billion.

The chart below shows the progress on the major plant expansion program undertaken several years ago to meet the need for a much larger capacity for production of nuclear products. The sharp reduction in construction work in progress at the end of 1955 shows that this expansion program is nearing completion.

INVESTMENT IN PLANT & EQUIPMENT



The table on the next page shows the amounts invested in the various types of facilities. It also shows that 80.7% of AEC plant is for production purposes, 11.4% for research installations, 4.7% for community facilities and 3.2% for administrative and other buildings and equipment.

Among the production facilities, the greatest investment has been made in gaseous diffusion plants where uranium 235 is separated

INVESTMENT IN PLANT AND EQUIPMENT

JUNE 30, 1955

	Completed Plant	Construction In Progress (in millions)	Total	Percent of Total
Production facilities:				
Gaseous diffusion plants, production reactors, and separations areas	$3, 463	$378	$3, 841	59. 2
Weapons production, fabrication, and storage	311	105	416	6. 4
Other	880	98	978	15. 1
TOTAL PRODUCTION	4, 654	581	5, 235	80. 7
Research facilities:				
Laboratories	418	14	432	6. 6
Civilian reactors	93	2	95	1. 5
Military reactors	98	18	116	1. 8
Accelerators	40	5	45	. 7
Other	49	5	54	. 8
TOTAL RESEARCH	698	44	742	11. 4
Communities	299	4	303	4. 7
Administrative and other	207	—	207	3. 2
TOTAL	$5, 858	$629	$6, 487	100. 0

from normal uranium. This process is dependent upon the extremely slight difference in mass of the two uranium isotopes. The separation involves several thousand stages in each of which the gas diffuses through porous barriers and the lighter U–235 is gradually separated and concentrated. Plants of this type are located at Portsmouth, Ohio; Paducah, Ky.; and Oak Ridge, Tenn. The plant at Oak Ridge is U-shaped nearly a mile long, averages 400 feet wide and 60 feet in height, and requires 60 acres of roof to cover it. It involves thousands of miles of pipe and thousands of pumps and control instruments, all of which must be leakproof and highly resistant to corrosion.

There is also a large investment in production reactors where plutonium and other nuclear products are made. These reactors are located at the Hanford project, Richland, Wash.; and at the Savannah River project near Augusta, Ga. Water from the Columbia and Savannah Rivers is used to cool the reactors. After plutonium is produced in reactors, it is separated from uranium and fission products by chemical means. Dangerous waste products are stored in large underground tanks. Much of the material must be handled by remote control.

The construction of these facilities must be of the highest quality and precision. All this naturally increases the cost of facilities. In fact, the AEC's investment in plant is $70,000 for each operating contractor employee which is higher than in any other major manufacturing industry.

Financial Statements

UNITED STATES ATOMIC COMPARATIVE

ASSETS	*June 30, 1955*	*June 30, 1954*
	(In thousands)	
Cash:		
In U. S. Treasury	$2,215,329	$2,896,999
With integrated contractors	31,949	44,630
	2,247,278	2,941,629
Working capital advances:		
With other Federal agencies	99,773	100,924
With nonintegrated contractors	4,418	4,597
	104,191	105,521
Accounts receivable, less allowance for uncollectible accounts of $192 thousand in 1955 and $209 thousand in 1954	10,665	7,084
Inventories:		
Production inventories in process	1,061,383	807,386
Source and special nuclear research material	143,612	103,716
Stores, less allowance for loss of $9,929 thousand in 1955 and $10,620 thousand in 1954	75,578	68,514
Special reactor material	16,689	16,143
Other special materials	11,296	3,858
	1,308,558	999,617
Prepayments and deferred charges	21,494	22,467
Plant:		
Completed plant and equipment	5,858,349	4,090,271
Less—Accumulated depreciation	1,069,620	860,148
	4,788,729	3,230,123
Construction work in progress	628,952	1,615,134
	5,417,681	4,845,257
Collateral funds and other deposits	29,352	30,225
TOTAL ASSETS	$9,139,219	$8,951,800

NOTES TO THE BALANCE SHEET

1. For security reasons inventories of stockpiled products are not included in assets in this report.
2. The balance sheet does not include 147,166,715 troy ounces of silver loaned to AEC by the Treasurer of the United States for use as electrical conductors in plants. Based on market quotations at June 30, 1955, this silver had a value of $133 million. Approximately 89,213,576 troy ounces are to be returned during the fiscal year 1956, costing $409,000 to process into bullion form.
3. Claims of $668,000 for refund of certain state taxes have not been included in receivables.
4. In addition to the liabilities shown on the balance sheet, AEC had at June 30, 1955:

ENERGY COMMISSION
BALANCE SHEET

Liabilities and AEC Equity	*June 30, 1955*	*June 30, 1954*
	(In thousands)	
Liabilities:		
Accounts payable and accrued expenses	$234, 845	$203, 258
Working fund advances from other Federal agencies	57, 017	86, 915
Funds held for others	6, 997	9, 015
Deferred credits	353	388
TOTAL LIABILITIES	299, 212	299, 576
AEC equity, July 1	8, 652, 224	8, 349, 365
Additions:		
Appropriated funds—net	1, 209, 860	1, 042, 492
Nonreimbursable transfers from other Federal agencies	3, 002	1, 985
	1, 212, 862	1, 044, 477
Reductions:		
Net cost of operations and adjustments to costs of prior years	1, 276, 280	1, 001, 305
Less—change in inventories of research materials and work in process	293, 893	267, 757
	982, 387	733, 548
Nonreimbursable transfers to other Federal agencies	29, 454	—
Funds returned to U. S. Treasury	13, 238	8, 070
	1, 025, 079	741, 618
AEC equity, June 30	8, 840, 007	8, 652, 224
TOTAL LIABILITIES AND AEC EQUITY	$9, 139, 219	$8, 951, 800

(a) contingent liabilities for claims against the Federal Government or AEC contractors of approximately $31 million; (b) contingent liabilities as guarantor on loans under the Defense Production Act of 1950 to the extent of $5.8 million; (c) commitments for vacation pay of AEC and contractor employees of $12 million; and (d) commitments applicable to future periods represented by unpaid obligations of $878 million.

5. The AEC has guaranteed minimum prices through March 1962 for domestic uranium ores and concentrates. In addition, bonuses are payable under certain specified circumstances to stimulate the discovery of new uranium sources. The AEC also has long-term commitments for the purchase of foreign ores, the development of foreign ore sources, and the return of residues of foreign ores processed in this country.

UNITED STATES ATOMIC ENERGY COMMISSION
COMPARATIVE STATEMENT OF OPERATIONS

	Fiscal Year ended June 30, 1955	*Fiscal Year ended June 30, 1954*
	(In thousands)	
Production costs:		
Procurement and production of source and special nuclear materials	$784, 888	$552, 336
Weapons program	259, 706	251, 066
	1, 044, 594	803, 402
Research expenses:		
Reactor development	118, 045	100, 096
Physical research	46, 502	44, 909
Biology and medicine	29, 702	27, 670
	194, 249	172, 675
Community operations:		
Expenses	31, 970	32, 113
Less—Revenues	(21, 597)	(20, 291)
	10, 373	11, 822
AEC administrative expenses	34, 027	34, 671
Security investigations	9, 817	12, 593
Other expenses	2, 158	9, 028
Other income	(5, 683)	(5, 013)
NET COST OF OPERATIONS	1, 289, 535	1, 039, 178
Credits applicable to prior years' cost—net	(13, 255)	(37, 873)
Net cost of operations—less credits applicable to prior years' costs	$1, 276, 280	$1, 001, 305

NOTE.—Costs of operations shown in this statement represent costs incurred during the year for procurement and production of source and special nuclear materials and weapons parts and assemblies, and includes depreciation of $237,-123 thousand in 1955 and $205,163 thousand in 1954.

AUDITOR'S REPORT

We have examined the balance sheet of the Atomic Energy Commission as at June 30, 1955 and the accompanying statement of operations for the fiscal year then ended.

These statements are a consolidation of financial statements of the ten AEC Operations Offices, the Washington Office, and their integrated contractors. In the AEC-wide audit examination thereof, the systems of control and related procedures affecting the principal activities including the accounting systems, of the AEC and its integrated contractors were reviewed, and without performing detailed audits of transactions, examinations or tests of the accounting records and supporting evidence were made by methods and to the extent contemplated by the AEC internal audit program and considered necessary in the circumstances. However, the audit program did not provide for nor did the audits include the verification of quantities and values of production inventories in process, source and special nuclear research materials, and stockpiled products.

Subject to the qualification noted in the preceding paragraph, and based upon the opinions furnished by the Chief Auditor of each Operations Office with respect to the financial statements of that Office, it is my opinion that the balance sheet and accompanying statement of operations, together with the notes thereto, fairly present the assets, liabilities and equity of the Atomic Energy Commission as at June 30, 1955 and the operating costs for the fiscal year then ended, in conformity with applicable AEC policies, contractual provisions, and generally accepted accounting principles.

Charles F. Schank
Assistant Controller for Auditing

September 30, 1955

SOURCES AND USES OF AEC FUNDS

Fiscal Year Ended June 30, 1955

	Operations	*Plant and Equipment* (*In millions*)	*Total*
Cash balance, July 1, 1954	$896	$2, 001	$2, 897
Funds provided by:			
Congressional appropriations—net	1, 099	111	1, 210
Working fund advances	9	—	9
Community revenues	22	—	22
Decrease in working capital	28	(2)	26
Other sources	19	—	19
TOTAL AVAILABLE	2, 073	2, 110	4, 183
Funds used for:			
Operations:			
Production costs	848	—	848
Research expense	167	—	167
Community expense	19	—	19
AEC administrative expense	33	—	33
Security investigations	10	—	10
	1, 077	—	1, 077
Plant and equipment	—	836	836
Work done for others	40	—	40
Funds returned to U. S. Treasury	10	3	13
Other uses	2	—	2
TOTAL USED	1, 129	839	1, 968
Cash balance, June 30, 1955	$944	$1, 271	$2, 215

CASH IN U. S. TREASURY—$2,215 MILLION

Cash shown on the balance sheet includes unexpended appropriations of $2,155 million at June 30, 1955, of which $1,113 million was committed for construction of facilities and for operations. The remainder of $1,042 million is available for fiscal year 1956 requirements. Also included are balances of working funds from other Federal agencies of $59 million for work which has not been completed, and agent-cashier funds, withholdings from employees' pay for taxes and savings bonds and other funds on deposit with the U. S. Treasury, totaling $1 million.

Cash in the U. S. Treasury decreased $682 million during fiscal year 1955; this includes a decrease of $730 million in plant and equipment funds and an increase of $48 million in funds available for operations.

CASH WITH INTEGRATED CONTRACTORS—$31.9 MILLION

The unused balance of cash advances to major AEC operating and construction cost-type contractors, who maintain records which are an integral part of the AEC accounting system, was reduced $12.7 million during the year. This reduction was accomplished by providing contractors with smaller amounts of cash at more frequent intervals to finance AEC activities, thus reducing interest expense to the Federal Government.

WORKING CAPITAL ADVANCES—$104.2 MILLION

Working capital advances are amounts advanced to other Federal agencies and nonintegrated contractors for the purpose of procuring materials or other assets or for the payment of costs incurred in AEC's behalf. The following schedule shows the unused portion of advances to other Federal agencies at June 30, 1955, and June 30, 1954.

	June 30, 1955	*June 30, 1954*
	(In millions)	
General Services Administration	$51.9	$35.7
Department of the Army	35.2	53.3
Department of the Navy	7.1	7.9
Department of Commerce	2.6	.5
Department of Interior	1.9	2.9
Other	1.1	.6
	$99.8	$100.9

Advances to contractors whose records are not integrated with those of AEC are usually relatively small or of short duration. Advances to such contractors amounted to $4.4 million at June 30, 1955, or $0.2 million less than at June 30, 1954.

ACCOUNTS RECEIVABLE—$10.7 MILLION

Accounts receivable arise from the sale of material and radioisotopes, from services performed for others, from refunds due AEC, and from rent, utilities, and other services provided tenants in AEC owned communities. The amount of these receivables increased $3.5 million in 1955.

Receivables shown on the 1955 balance sheet have been reduced by an allowance for uncollectible accounts estimated at $0.2 million.

PRODUCTION INVENTORIES IN PROCESS—$1,061 MILLION

Production inventories in process consist of uranium and thorium source materials, special nuclear and thermonuclear materials, and weapons materials and parts. The increase of $254 million in 1955 over 1954 reflects the increased production activity made possible by putting new plants into operation. For security reasons stockpiled products are not included in inventories in this report.

SOURCE AND SPECIAL NUCLEAR RESEARCH MATERIAL—$143.6 MILLION

This includes source and special nuclear research materials that have been diverted from the production process for use in research and development activities. The increase of $40 million in 1955 over 1954 is the result of increased emphasis on these activities. Although a portion of these materials will be consumed in research, the bulk of the inventory could be returned to the production process if necessary.

STORES—$75.6 MILLION

Stores inventories include the cost of materials, supplies, and parts on hand normally used or consumed in operations, maintenance, and general use. For management purposes, stores inventories are divided into those for current use, items held in standby for future use, and those which are excess to the needs of the contractors. The amounts in these three categories are as follows:

	June 30, 1955	*June 30, 1954*
	(In millions)	
Current use	$78.5	$66.9
Standby	.6	4.8
Excess	6.4	7.4
Total	85.5	79.1
Less allowance for loss	9.9	10.6
	$75.6	$68.5

Stores inventories increased only 8% during 1955 while the total cost of operations increased 24%. Current use materials and supplies in inventory at June 30, 1955 represent an amount which on the average will be used in 4.9 months. The decrease of $4.2 million in standby inventories in 1955 was due to transfers of certain items to the current use category.

Stores inventories shown on the balance sheet for 1955 have been reduced by $9.9 million for estimated losses that may be incurred through handling or disposal of obsolete or excess supplies and spare parts.

SPECIAL REACTOR MATERIAL—$16.7 MILLION

Special reactor material includes beryllium, zirconium and other material which is not available through the usual channels in sufficient quantity because of limited commercial production or applications unique to AEC's field of activity. This material is for use in reactor operations and for research.

OTHER SPECIAL MATERIALS—$11.3 MILLION

Other special materials are those materials that generally have a high monetary value in relation to volume and weight. They include radium, gold, silver, platinum, palladium, and certain other special materials.

PREPAYMENTS AND DEFERRED CHARGES—$21.5 MILLION

Payments made in advance for goods and services and costs applicable to future periods decreased to $21.5 million at June 30, 1955 from $22.5 million at June 30, 1954. The most significant item at June 30, 1955, is $17.5 million advanced against future production of raw materials, to aid in the development of source material ore deposits. These advance payments are reduced, under the terms of the agreements for purchase of ores, as deliveries are received.

COMPLETED PLANT AND EQUIPMENT—$5,858.3 MILLION

The cost of a plant construction project or an operative unit within a project is transferred to completed plant and equipment from construction work in progress when the facilities are placed in service.

The following table shows the major types of assets included in completed plant and equipment:

	June 30, 1955	*June 30, 1954*
	(In millions)	
Land and improvements	$194.8	$150.9
Buildings and structures	1,869.0	1,521.5
Equipment	2,961.6	1,838.7
Utilities	816.0	573.1
Other	16.9	6.1
TOTAL COST	5,858.3	4,090.3
Less accumulated depreciation	1,069.6	860.1
DEPRECIATED VALUE	$4,788.7	$3,230.2

CONSTRUCTION WORK IN PROGRESS—$629 MILLION

Construction work in progress includes partially completed plant and equipment, inventories of construction materials and supplies, construction equipment, and temporary construction facilities. The amount in progress decreased to $629 million at June 30, 1955, from $1,615 million at June 30, 1954, or 61%. The major items transferred to completed plant and equipment during fiscal year 1955 were gaseous diffusion facilities at Portsmouth, Ohio; Paducah, Ky.; and Oak Ridge, Tenn., and production reactors at the Savannah River, Georgia and Hanford, Wash., projects. Construction costs during fiscal year 1955 amounted to $842 million or 31% less than costs of $1,215 million for 1954.

COLLATERAL FUNDS AND OTHER DEPOSITS—$29.4 MILLION

Collateral funds are deposits with insurance companies to fund reserves for immediate use in the event of a catastrophe. Other deposits include deposits with contractors to provide funds for payments to employees suffering disabilities from certain causes, deposits in escrow to provide funds for the purchase of pension benefits and annuities for contractors' employees, and other funds established pursuant to specific contractual agreements.

The following table shows a breakdown of collateral funds and other deposits:

	June 30, 1955	*June 30, 1954*
	(In thousands)	
Insurance collateral funds	$18, 600	$18, 600
Employee benefit funds of cost-type contractors	4, 290	5, 290
Sundry collateral and special contract funds	3, 655	3, 610
Insurance deposits	1, 779	1, 640
Other deposits	1, 028	1, 085
TOTAL	$29, 352	$30, 225

ACCOUNTS PAYABLE AND ACCRUED EXPENSES—$234.8 MILLION

Unpaid costs of goods and services received include amounts owed for raw materials, supplies, special reactor and other materials, power, equipment, wages earned by employees, and services performed by nonintegrated contractors or other Federal agencies. Accounts payable and accrued expenses increased to $234.8 million at June 30, 1955, from $203.3 million at June 30, 1954.

WORKING FUND ADVANCES FROM OTHER FEDERAL AGENCIES—$57 MILLION

Unexpended balances of funds advanced to AEC by other agencies in contemplation of receiving services, materials, or other assets from AEC decreased to $57.0 million at June 30, 1955 from $86.9 million at June 30, 1954.

FUNDS HELD FOR OTHERS—$7.0 MILLION

Funds held by AEC and its integrated contractors which belong to others include amounts deducted from employees' pay for income taxes, savings bonds, social security, and insurance. They also include collections made for other governmental units such as states and municipalities as well as deposits received on containers and other items.

DEFERRED CREDITS—$0.4 MILLION

Deferred credits are liabilities for amounts which have been received but for which the goods have not been delivered or the services rendered. They will therefore be earned in the next or succeeding fiscal periods and will be recorded either as income or reductions of cost at that time. The amount decreased $35 thousand in 1955.

AEC EQUITY—$8,840.0 MILLION

The interest of the United States Government in AEC assets increased $188 million in 1955. In this report, it is understated for security reasons by the cost of stockpile product inventories.

The schedule on the next page shows the investment of the United States Government in the Atomic Energy program.

U. S. GOVERNMENT INVESTMENT IN THE ATOMIC ENERGY PROGRAM

From June 1940 through June 1955

	Amount (In millions)	
Appropriation payments net of reimbursement:		
National Defense Research Council	$0.5	
Office of Scientific Research and Development	14.6	
War Department (including Manhattan Engineer District):		
Fiscal year 1943	77.1	
Fiscal year 1944	730.3	
Fiscal year 1945	858.6	
Fiscal year 1946	366.3	
Fiscal year 1947—part	186.0	
		$2,233.4
Atomic Energy Commission:		
Fiscal year 1947—part	146.1	
Fiscal year 1948	477.6	
Fiscal year 1949	627.3	
Fiscal year 1950	534.3	
Fiscal year 1951	920.5	
Fiscal year 1952	1,669.4	
Fiscal year 1953	1,812.7	
Fiscal year 1954	1,930.5	
Fiscal year 1955	1,861.9	
		9,980.3
TOTAL PAYMENTS—Net		12,213.7
Unexpended balance of appropriation, June 1955		2,154.7
TOTAL APPROPRIATED FUNDS		14,368.4
Less:		
Collections paid to U. S. Treasury	43.5	
Property and services transferred to other Federal agencies without reimbursement, net of such transfers received from other Federal agencies	26.6	
		70.1
TOTAL INVESTMENT THROUGH JUNE 30, 1955		14,298.3
Less:		
Cost of operations including depreciation and obsolescence from June 1940 through June 30, 1955		5,458.3
AEC equity at June 30, 1955		$8,840.0

U. S. GOVERNMENT PRINTING OFFICE: 1956