UNITED STATES ATOMIC ENERGY COMMISSION

MAJOR ACTIVITIES

IN THE

ATOMIC ENERGY PROGRAMS

January–June 1953

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ATOMIC ENERGY COMMISSION

UNITED STATES OF AMERICA

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FOREWORD

The past half-year in the atomic energy program has been a period of consolidating advances in production which began 2 years or more ago with actions to expand processing plant capacity and the uranium supply both at home and abroad. South Africa came more prominently into the uranium supply situation, and United States production and exploration mounted in volume.

During the 6 months the new feed materials plant at Fernald, Ohio, and portions of the new fissionable materials plants at Oak Ridge, Tenn., Paducah, Ky., and supporting facilities at Savannah River, S. C., joined the production stream. The net of the additions and changes in plants and operations was again, as in each half-year of the past five, more output at lower cost per unit.

Construction continued at an accelerating pace on the $3.5 billion in additional plant facilities yet to be completed under previous Congressional authorizations. Atomic energy projects account at present for about 3 percent of the expenditures for new construction in the United States. The proportion next year will be 5 percent.

Weapons development was substantially advanced as an outcome of the longest and most complex series of tests yet held. The report includes data on fall-out of radioactive particles resulting from tests.

As in previous tests, no hazard to health or safety of populated areas resulted. There were livestock injuries in areas very near the proving ground, where animals graze at the risk of the owners. Final study of livestock cases is still in progress and results were incomplete as this report goes to press.

In the field of biological and medical applications the outstanding event of the period was the completion of the cancer research hospital at the Argonne National Laboratory. Marking this occasion, this report briefly reviews the status of AEC studies in the drive against cancer.

The equipment for physical research in atomic energy was further expanded. A new computer was installed at New York University, and new computing machines for Argonne and Oak Ridge National Laboratories were virtually completed.

The events for which the period may be best remembered, however, occurred in the reactor and power phases of the atomic energy program. The breeding process was demonstrated when it was determined that the experimental breeder reactor at The National Reactor Testing Station in Idaho, was producing at least as much fissionable material as it was consuming. The submarine thermal reactor, also located at The National Reactor Testing Station, generated substantial amounts of power, and the first experimental homogeneous nuclear power plant operated successfully at the Oak Ridge National Laboratory. These advances in reactor knowledge were accompanied by the most extensive consideration and discussion yet given to the problem of national policy toward development of electric power from atomic fuels. The Joint Congressional Committee on Atomic Energy has requested the views of the AEC on such policies. The Commission formulated these views and with the approval of the National Security Council presented them to the Joint Committee. The latter was in full stride on a program of hearing all interests and persons concerned in the field as the fiscal year ended.

Before the start of this extensive series of hearings, the Commission published the declassifiable portions of the analyses made by the four industrial power study groups whose activities have been noted in these reports over the past two years. The volume of attention by periodicals, newspapers, and radio and TV networks to the developments in power research and the problems of atomic power policy, and the range of discussions on these topics at meetings of professional and lay groups was far greater than ever before.

The term of service of Gordon Dean as chairman of the Commission expired at the end of the period reported on. To succeed him, the President appointed Lewis L. Strauss on June 24 and he assumed office on July 2. This report, covering the final 6 months of Mr. Dean's service as chairman, is signed by him. In the staff, William Mitchell succeeded Everett Hollis as General Counsel.

Raw Materials

The first half of 1953 witnessed continued progress in all phases of the Commission's raw material procurement program.

Foreign producers of uranium continued to make a major contribution to the atomic energy program. Production from the Union of South Africa assumed increasing importance, and construction of new uranium production facilities in Australia showed substantial progress. Exploration activities in foreign countries were expanded.

In the United States, higher procurement goals were met and exploration activities continued at a high level. New advances in research and process development occurred. Studies on techniques for recovering uranium from the Chattanooga and possibly other uraniferous black marine shales continued.

Domestic Production

Production of uranium from domestic ores again showed substantial gains. Production also included some byproduct uranium from the treatment of phosphate rock by the Blockson Chemical Co., at Joliet, Ill. Additional plants for byproduct recovery of uranium from phosphate rock were nearing completion at Mulberry, Fla., by International Minerals and Chemical Corp. and Virginia-Carolina Chemical Corp., and at Texas City, Tex., by Texas City Chemicals, Inc. The Commission established a small production office at Plant City, Fla., the center of the Florida phosphate mining industry, because of the increased activity in uranium recovery from phosphates.

Construction of a new ore-processing mill by Anaconda Copper Mining Co., near Grants, N. Mex., is nearing completion and the plant is expected to be in operation this fall. This will bring to nine the number of uranium mills on the Colorado Plateau. New ore-processing mills also are planned by Kerr-McGee Oil Industries, Inc., at Shiprock, N. Mex., and by Vanadium Corp. of America at Hite, Utah. The first will treat ores produced in the Lukachukai Mountains area, and the second will treat ores from the White Canyon area, replacing a small plant operated by VCA for several years. Consideration also is being given by Anaconda to the construction of additional ore treatment facilities at its Grants plant to handle sandstone-type ores being produced in the area, which are not amenable to treatment by the present facilities. VCA has modified and expanded its Durango, Colo., plant, with a resultant increase in production.

Foreign Production and Exploration

Deliveries of uranium to the United States from foreign sources during the first half of 1953 continued at a steady rate. South Africa joined the Belgian Congo and Canada as a supplier of uranium to the free world.

South Africa

The West Rand Consolidated Gold Mines Co., Ltd., which began operating in October last year, was joined in April by new plants of Blyvooruitzicht Gold Mines Co., Ltd. and Daggafontein Mines, Ltd. Additional plants will be completed at intervals over the next several years.

Canada

Production by Eldorado Mining & Refining Co., Ltd., from the Eldorado Mine on Great Bear Lake in the Northwest Territory met schedules. At Beaverlodge, in the Lake Athabaska area of Northern Saskatchewan, the first ore treatment plant was completed. A major shaft being sunk by Eldorado at Beaverlodge to serve three of its properties will be in operation this summer, and the first production of uranium from the Lake Athabaska area will occur this year.

Active exploration in the area surrounding Lake Athabaska resulted in the discovery of a large orebody by Gunnar Gold Mines, Ltd. This major discovery by private interests has further stimulated activity by prospectors and mining firms in the search for uranium deposits.

Australia

First production of uranium in Australia will be from the Radium Hill deposit in South Australia. The property is being rapidly developed and the concentrator under construction at Port Pirie to treat ores from Radium Hill will be completed in early 1954. Exploration and development at Rum Jungle in the Northern Territory is continuing with the objective of determining the extent of the ore reserves. A production plant is being designed and constructed. This operation is being directed by Territory Enterprises Proprietary, Ltd., a subsidiary of the Zinc Corp., a leading Australian mining firm.

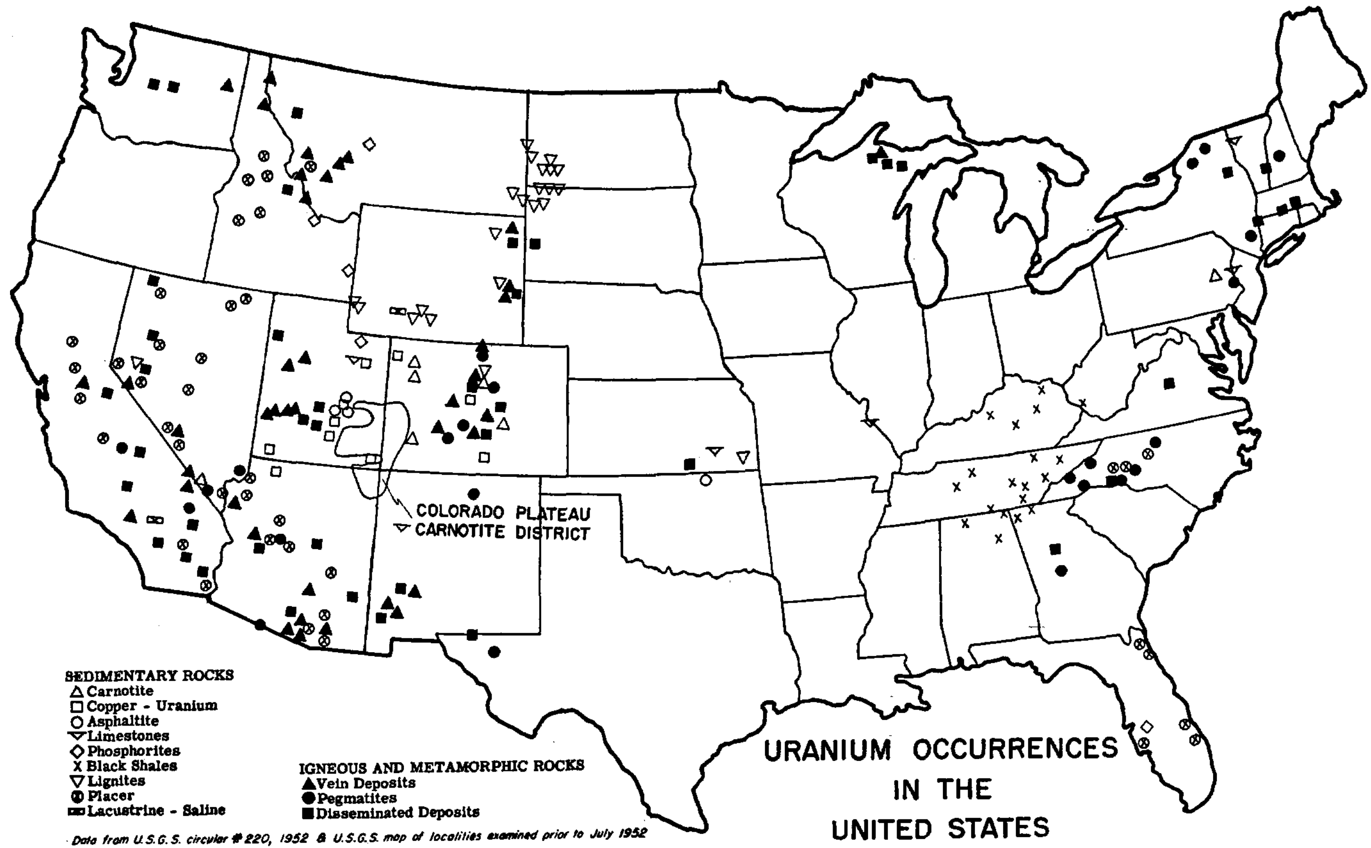
Domestic Exploration

The Colorado Plateau continued to be the center of the Commission's domestic exploration program. However, new centers of potential production are becoming increasingly important. An outstanding example is the area in South Dakota and Wyoming surrounding the Black Hills, where a substantial output of ore now is being delivered to the Commission's ore-buying depot at Edgemont, S. Dak. The Marysvale, Utah, area continued to be an important producer during the last 6 months, and minor production was obtained from a number of properties in the Colorado Front Range and the Boulder Batholith region of Montana. Recent discoveries of new ore occurrences in a number of widely separated points in Arizona resulted in increased prospecting and exploration activity in that state, and several of the properties are producing ore.

The map on page 4 illustrates the wide distribution of uranium occurrences in the United States and the varied types of deposits that have been found to be uraniferous. The carnotites, copper-uranium, asphaltite and limestone-type ores occurring in sediments, and the primary vein deposits have been the only important uranium producers to date, although the AEC and the U. S. Geological Survey have examined every known ore type in their search for commercial deposits. The Commission is actively investigating the potentialities of several of the low-grade sources, such as phosphates, shales, lignites and fluorspars.

Action by Other Federal Agencies

The U. S. Geological Survey conducts basic geological, geophysical, and mineralogical studies for the Commission and carries on about half the domestic exploration. A number of other Government agencies also have taken an active part in the raw materials program. The U. S. Bureau of Mines has had a modest program involving drilling and evaluation of monazite deposits, a source of byproduct thorium, and certain uranium deposits. The Bureau recently undertook an investigation of the Chattanooga shale formation, which will include operation of an experimental mine for the Commission in Tennessee as part of the uraniferous shale project. The Bureau also has made substantial contributions to the process development program of the Commission. Financial aid for the investigation of uranium prospects continued to be provided to private interests by the Defense Minerals Exploration Administration. At the end of May 1953, approximately $890,000 in loans had been approved by Defense Minerals Exploration Administration for exploration and


URANIUM OCCURRENCES
IN THE
UNITED STATES
COLORADO PLATEAU
CARNOTITE DISTRICT
SEDIMENTARY ROCKS
Carnotite
Copper - Uranium
Asphaltite
Limestones
Phosphorites
Black Shales
Lignites
Placer
Lacustrine - Saline
IGNEOUS AND METAMORPHIC ROCKS
Vein Deposits
Pegmatites
Disseminated Deposits
Data from U.S.G.S. circular # 220, 1952 & U.S.G.S. map of localities examined prior to July 1952

development at 36 potential uranium mines in 6 states. The U. S. Bureau of Reclamation contributed to the program by carrying on geophysical studies on the Colorado Plateau. The U. S. Bureau of Public Roads has supervised access road construction.

Petroleum Industry Program

Through the efforts of a committee representing the American Association of Petroleum Geologists, the Society of Exploration Geophysicists, and the Society of Economic Paleontologists and Mineralogists, a cooperative program has been launched to utilize the exploration potential of the petroleum industry in uranium exploration. The program includes: (1) equipping of seismographic field crews with radiation detection equipment by several major oil companies, (2) active exploration for radioactive ores by certain independent producers, (3) examination of all gamma ray well-logs for indications of radioactivity by major well-logging companies, (4) addition of radiometric surveying as a service offered by some consulting geophysical companies, and (5) monitoring of cuttings from seismic shot holes for radioactivity.

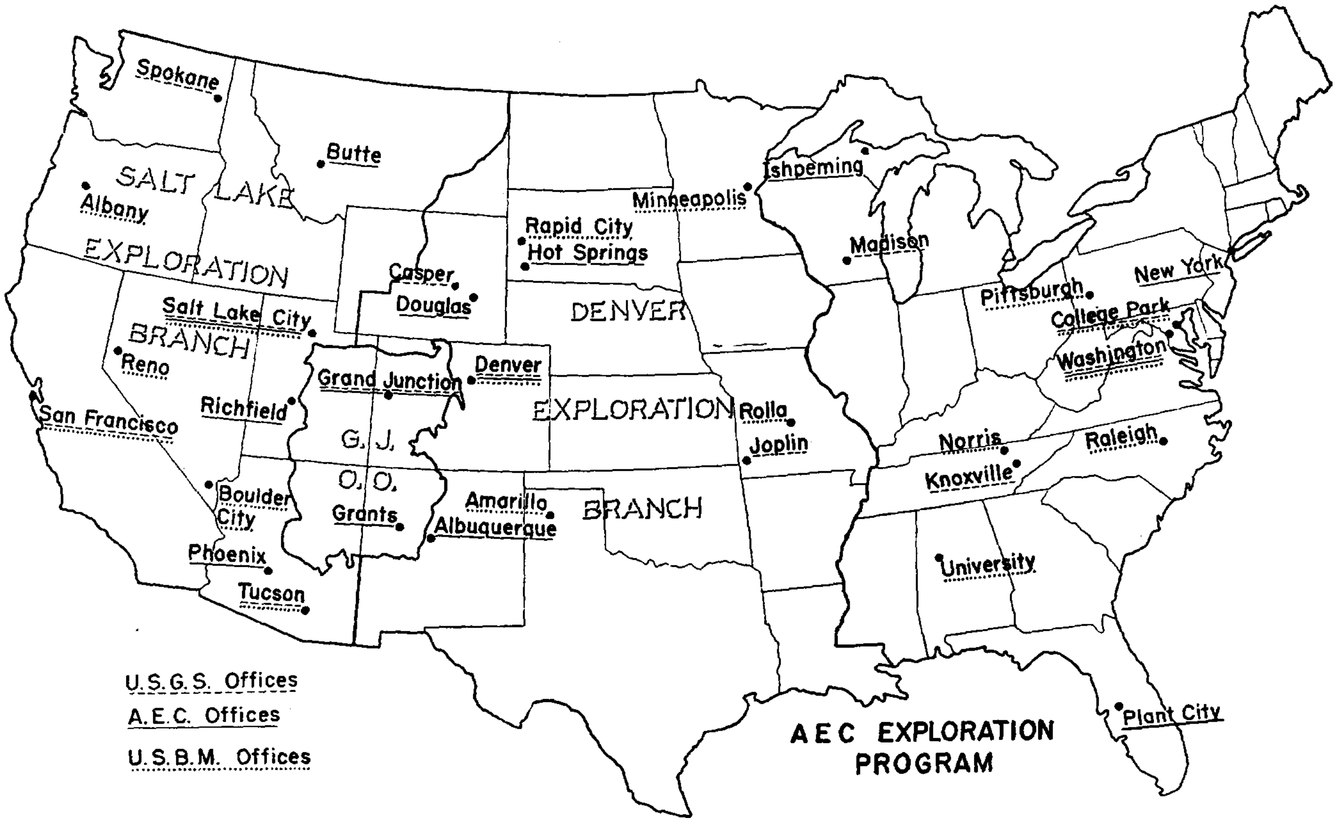
Airborne Radiation Surveying

The use of airborne radiation surveying was expanded, with airborne surveys being carried on in Wyoming, South Dakota, Arizona, New Mexico, Utah, and Pennsylvania. Private companies as well as the Commission are using this important reconnaissance technique. Its value is borne out by the fact that three-quarters of the ore produced to date in the Black Hills area came from deposits originally indicated by airborne surveying.

Additional Exploration Offices

Expansion of the Commission's exploration program during early 1953 made necessary the establishment of additional suboffices at Douglas, Wyo., Phoenix, Ariz., Albuquerque, N. Mex., and Ishpeming, Mich. The new production suboffice at Plant City, Fla., also will perform functions in connection with the exploration program. The map on page 6 shows all the offices of the Commission, U. S. Geological Survey and U. S. Bureau of Mines from which uranium exploration activities are directed and at which assistance may be obtained by industry and the public.[1]

[1] Discussions of the services available at these offices for prospectors are included in the Eleventh and Thirteenth Semiannual Reports to Congress on pages 8 and 10 respectively.


Spokane
Butte
SALT LAKE
Albany
EXPLORATION
Salt Lake City
BRANCH
Reno
Richfield
San Francisco
Boulder City
Phoenix
Tucson
Casper
Douglas
Grand Junction
G. J.
O. O.
Grants
Denver
Amarillo
Albuquerque
Rapid City
Hot Springs
DENVER
EXPLORATION
BRANCH
Minneapolis
Ishpeming
Madison
Rolla
Joplin
Pittsburgh
New York
College Park
Washington
Norris
Knoxville
Raleigh
University
Plant City
U.S.G.S. Offices
A.E.C. Offices
U.S.B.M. Offices
AEC EXPLORATION
PROGRAM

RAW MATERIALS RESEARCH

Research in the field of raw materials involves studies in basic geology, geophysics, and mineralogy, in the development of new ore treatment processes, and in the improvement of ore treatment processes now in use.

Research in Geology

Research by competent institutions and individuals is an important part of the Commission's exploration program, influencing the approach and emphasis of the actual reconnaissance and physical exploration. New and more effective exploration techniques have resulted from the research program. These include the development of geologic guides or criteria for conducting physical exploration and the development of instruments and equipment for the laboratory and field, such as drill hole logging devices and carborne and airborne radiation detection equipment.

Interesting developments have been made in the application of geophysical techniques other than radiation detection to the exploration program. These include seismic refraction, electrical resistivity surveying, natural potential studies, and the electric-logging of drill holes and wells. A study of the application of geothermal measurements also is contemplated.

The Commission has a field program under way on the Colorado Plateau which will determine the effectiveness of geophysical methods in uranium exploration. Other techniques being investigated include geobotanical prospecting studies by the USGS. These studies involve the collection and analysis of plant material in favorable locations. The application of this method, while limited, has resulted in at least one ore discovery. Exploration techniques using geochemical methods are also being developed.

Fundamental geological and mineralogical studies have been pursued to determine origin and manner of occurrence of uranium and its associated elements. Analytical methods have been developed and improved, and basic studies in thorium mineralogy have been made. A large part of the program has been carried on by the USGS. Educational institutions participating in the program include Amherst College, Armour Research Foundation, University of Arizona, Columbia University, Harvard University, Iowa State College, University of Minnesota, Pennsylvania State College, Stanford University, University of Tennessee, and the University of Utah.

Research in Process Technology

New processes continually are being sought for the more efficient and economical recovery of uranium from its various ores, as well as the recovery of uranium from new types of ore deposits and the recovery of the small quantities of uranium occurring in several low-grade materials, such as phosphates, shales, and lignites. Results of these studies have had application to foreign as well as domestic ores.

The several types of ores on the Colorado Plateau, such as the copper-uranium, asphaltite, uraninite, the high and low-vanadium content carnotites, the roscoelites, and the limestone-type ores, each have required special study.

Several years of intensive research preceded the initial production of byproduct uranium from Florida pebble phosphate, and considerable research and process development still is under way in this field. Phosphate rock is the first domestic low-grade source of uranium, and efforts are continuing to utilize the uranium present in other low-grade materials. These include additional phosphatic sources such as the phosphoria formation of Montana, Idaho, Wyoming and Utah, and the submarginal phosphate beds overlying the commercial phosphate rock in Florida.

Uraniferous Shale Project

An investigation of the economic feasibility of extracting uranium from the uraniferous shales of the southeastern United States has been launched. On January 30, the Commission announced that a small experimental mine will be operated by the U. S. Bureau of Mines in Tennessee to develop a satisfactory method for mining these shales. The USGS and USBM are conducting a drilling program on the Chattanooga shale to obtain better knowledge of the uranium occurrence. Studies in basic geology and mineralogy have been under way for some time at the University of Tennessee and Pennsylvania State College. These and other basic studies relating to the shale and phosphate programs are described on page 32.

Concurrently with the studies in geology and mining the Commission has initiated process studies at Columbia University, Battelle Memorial Institute, and the Oil Shale Experimental Plant of the Bureau of Mines at Rifle, Colo.

The program is directed not only toward the extraction of uranium but also toward the byproduct recovery and utilization of other components of the shale. The Chattanooga shale is not at present an economic source of uranium, but it is hoped that extraction of the uranium and other components of the shale may become economically feasible.

Process Development

After new processes are discovered, they must be developed into economic and efficient methods of recovery in the mill. This involves studies in materials handling, equipment design and application, flowsheet design and cost estimates.

The several plants now under construction to recover uranium from phosphate rock, Colorado Plateau ores, and foreign sources, such as the gold ore residues of South Africa, are the result of extensive research and process development. The center of the Commission's process development activity is the Raw Materials Development Laboratory, which went into full operation early this year at a new location in Winchester, Mass. The laboratory, operated for the Commission by the American Cyanamid Co., previously was located in Watertown, Mass.

Other important contractors in this program are the Rohm & Haas Co., of Philadelphia; Dow Chemical Co. at its Pittsburg, Calif., laboratories; International Minerals & Chemical Corp., U. S. Phosphoric Products, both in Florida; the Merrill Co., San Francisco; the Tennessee Valley Authority at Muscle Shoals, Ala., and Armour Fertilizer Works, Chicago, Ill. In addition to the developmental work in the laboratories, an important phase of the program has been the on-site plant assistance rendered by contractor personnel in setting up and operating laboratory facilities, pilot plants and full scale treatment plants.

Pilot Plants for Western Ores

On the Colorado Plateau, American Cyanamid Co. is operating a recently-completed pilot plant at Grand Junction to test new extraction processes on various types of ore. Another pilot plant has been set up at Monticello, Utah, to attack special problems.

New processes also are being tested by Anaconda Copper Mining Co. at Grants, N. Mex., and the Climax Uranium Co. at Grand Junction, Colo. Personnel from Winchester are working jointly with the Bureau of Mines station at Salt Lake City on pilot testing a flowsheet for the proposed Shiprock plant.

Production

Production schedules for the first 6 months of 1953 were met, and the amount of fissionable materials produced considerably exceeded that of any previous period. Unit costs of production continued to decline, and now are at the lowest level in the AEC's history, despite increases in wages and material prices.

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Construction Progress

The record output resulted from the completion and successful operation of several production facilities. Part of the gaseous diffusion facilities at the Paducah, Ky., plant is in operation. At Hanford, a new reactor and a chemical processing plant have contributed to plutonium production. Some of the supporting facilities at Savannah River are already in operation, preparing materials for start-up of the first major production units at that site.

Construction of the Feed Materials Production Center at Fernald, Ohio, was essentially complete by June 30, with a few units still under construction.

Construction of the expanded production facilities authorized a year ago proceeded essentially as scheduled. A reanalysis of the land requirements for the new plant at Portsmouth, Ohio, resulted in the reduction of the area to be acquired from the 6,500 acres previously planned to 3,700 acres. As of June 30, 73 percent of this land had been acquired. Peter Kiewit Sons' Co. of Omaha, Nebr., the general construction contractor for the Portsmouth plant, has selected its major subcontractors. They are the Grinnell Corp. of Providence, R. I., for the mechanical work; Reynolds Electrical and Engineering Co. of El Paso, Tex., and the Newberry Electrical Corp. of Los Angeles, Calif. (coventurers) for the electrical work; and George N. Koch Sons', Inc., of Evansville, Ind., for the sheet metal work.

Electric Power for Paducah

The first electric generator unit of TVA's Shawnee, Ky., steam plant began commercial operation on April 9, 1953. Test operation of the first unit of the Joppa plant of Electric Energy Inc. was resumed late in June after the completion of some design modifications. These two plants are under construction to supply electric power to the Paducah gaseous diffusion plants.

Electric Power for Portsmouth

The Ohio Valley Electric Corp., under contract with AEC to supply 1.8 million kilowatts of power to the Portsmouth plant, started construction of its two steam electric generator plants. More than a million cubic yards of dirt have been moved at each plant site. The first "pour" of concrete was made late in April at the Kyger Creek plant, near Cheshire, Ohio, and early in May at the Clifty Creek plant, near Madison, Ind.

Construction and Supply

As of January 1, 1953, the Nation's capital investment in atomic energy plant facilities was about $4 billion, which is approximately equal to the total invested in plant and equipment of the United States Steel Corp., in both cases before depreciation. An additional $3.5 billion has been authorized in budgets for fiscal year 1953 or earlier years for construction of new AEC plant facilities.

Construction activity for the expansion of atomic energy production facilities authorized by Congress in July 1952 continued at a high level during the first half of 1953. During this period, costs incurred for the overall AEC plant and equipment program averaged about $92 million a month, and accounted for approximately 3 percent of the total expenditures for new construction in the United States. It is anticipated that monthly costs will increase gradually during the latter half of 1953, reaching a peak of about $130 million during the early part of 1954. They will then approximate 5 percent of total estimated United States new construction expenditures.

Transportation

Negotiations with rail carriers resulting in freight rate reductions for the transportation of uranium ore served to stimulate uranium production in certain areas of Arizona and Colorado by making it feasible for operators to ship to marketing points ore produced in the course of development.

Small Business

The Commission has an established small business program which operates in conjunction with the procurement activities of the AEC operations offices and cost-type contractors. The program is designed to assure that a fair proportion of total supplies and services shall be procured from small business concerns. In March 1953, the AEC activities for small business were supplemented by a joint Atomic Energy Commission-Small Defense Plants Administration agreement. This agreement provided for exchanges of information between appropriate AEC operations offices and cost-type contractors and SDPA regional offices regarding AEC procurement opportunities, small business firms qualified to participate in AEC procurement, and other matters.

Small business received direct contract awards amounting to $36.1 million, or 2.2 percent of the $1.6 billion total dollar value of AEC contracts awarded from July 1, 1951, to March 31, 1953. Since it continues to be necessary for most construction programs and the operation of major facilities to be carried out by large, cost-type contractors, their award of subcontracts provides the best opportunity for small business participation in the atomic energy program. Subcontract figures for AEC cost-type contractors during the period July 1, 1951, to March 31, 1953, showed awards amounting to $521 million. Small business concerns were awarded $225.6 million, or 43.3 percent of the total.

Priorities

The AEC continued to function under the national priorities system as a claimant agency with respect to allotments of steel, copper, and aluminum required for its construction and operating programs. The "open ending" of the Controlled Materials Plan (CMP) effective March 1, 1953, did not affect AEC procurement since the advantages accorded delivery orders bearing the AEC program identifications remained in full force and effect.

Necessary administrative actions were taken to assure an orderly transition from operations under the Controlled Materials Plan, which applied to all production and construction, to operations under the Defense Materials System, which replaces CMP with respect to orders calling for delivery after July 1, 1953, and which applies only to AEC and military programs.

A priority rating, designated E-5, was made available by NPA for assistance to the power supply projects essential to the AEC expansion programs at Oak Ridge, Paducah, and Portsmouth. However, the problem of assuring adequate power for these expansion programs is still critical and is receiving close attention from the Commission.

Licensing Controls

Several reports have come to the attention of the Commission indicating that domestic radioactive uranium and thorium ores are being advertised as having beneficial effects in the treatment of arthritis, rheumatism, bursitis, and other ailments. In at least two instances, AEC licenses issued to authorize transfers of ores to AEC-licensed ore processors were being referred to or displayed in such a manner as to give the incorrect impression that the Atomic Energy Commission had authorized or sanctioned the use of such ores for treatment of these afflictions. From the information presently available to the Commission, there appears to be no basis for concluding that exposure to radioactive ore is of any therapeutic value. In view of the diversion of ore from production channels that is involved, the Commission is guarding against the transfer of ore for such uses. The Commission also has provided information to other Federal agencies concerned regarding the use of uranium ore in this manner.

Military Application

Atomic weapons production proceeded at the rate authorized by the President. Research continued to be directed at improvement of current weapon models and development of new models to meet the requirements of the Armed Forces.

The construction of the facility at Rocky Flats, near Denver, Colo., will be completed this summer and shakedown of those portions of the plant not currently in operation will commence.

In January, a site near Macomb, Ill., was selected for a new explosives processing and assembly plant. The new plant will not handle radioactive materials.

Selection of this site, the former location of World War II Camp Ellis, was based on factors including availability of Government-owned land suitable for operating requirements, proximity of communities where housing can be provided by private enterprise for operating employees, and availability of utilities, labor, and transportation. Construction of the new AEC plant, named the Spoon River plant, is scheduled to begin in August 1953.

The Reynolds Electrical and Engineering Co. was awarded a contract providing for test construction, test support, maintenance and operation of the permanent facilities at the Nevada Proving Ground. All contract work at the Nevada Proving Ground now is being performed on a lump sum or unit price basis except for this contract and the architect engineer services.

A contract for construction and maintenance at Los Alamos, formerly held by the Zia Co., has been divided between the Zia Co. and a new company, Los Alamos Constructors, Inc., which was organized and staffed by the Zia Co. The division provides that maintenance within the Los Alamos community and the technical area will be performed by the Zia Co., and purely construction activities will be performed by Los Alamos Constructors, Inc.

Test Activities

A series of 11 nuclear detonations for test purposes was conducted during March, April, May, and June at the Nevada Proving Ground. This was the longest and most complex series yet conducted at the

Nevada Proving Ground, and these tests were undoubtedly the most important events in this period in the weapons field.

The major results of these test operations have been to indicate several very profitable avenues to new and improved weapons, and thus to afford the opportunity of substantially greater atomic weapons capability for the United States. The 11th shot, added late in the series, emphasized the value of the continental test site in that it permitted the shot to be scheduled, fired, and the data returned to the laboratory all within the space of one month, thus enhancing the speed of weapon development activities. This added shot has obviated the necessity of a full-scale test series originally planned for the fall of 1953.

As in the past, the Commission, in conducting the tests, worked closely with the Department of Defense, the Federal Civil Defense Administration, and other government agencies and private enterprises participating under contract with the various government agencies. The Commission, through its contractors, was responsible for the test devices and diagnostic measurements, while measurements of effects were performed by the other interested agencies.

The Department of Defense again took advantage of several of the detonations for indoctrination of personnel in the effects of atomic weapons and for simulated combat maneuvers.

The Federal Civil Defense Administration subjected two typical American frame dwellings and 51 vehicles to the effects of the first detonation in the series. The tenth shot in the series was the first firing of a nuclear round from the Army's 280 millimeter cannon.

To provide flexibility in testing new and improved nuclear weapons, the Commission is enlarging its Pacific Proving Grounds in the Marshall Islands to include Bikini Atoll, and construction of technical facilities there is under way. Bikini, last used in 1946 for testing military effects of atomic bombs, is 180 miles east of Eniwetok Atoll.

Community Operations

In April, the Commission submitted to the Bureau of the Budget a draft of legislation to facilitate the establishment of self-government and to provide for private ownership of residential and commercial property in Oak Ridge and Richland. The plan approved by the Commission is based on recommendations of an advisory panel of private individuals experienced in the fields of housing and community operations. Residents of Oak Ridge and Richland had indicated general approval of the panel's recommendations in surveys conducted by the Census Bureau in the summer of 1952.

Establishment of self-government at the two communities is in part dependent on State law. The Washington legislature has enacted enabling legislation under which Richland could incorporate upon vote of the residents. Tennessee practice requires approval of city charters by the State legislature. To pave the way for charter approval at the present session of the Tennessee legislature and thus avoid the necessity of waiting until the 1955 session, an advisory referendum of Oak Ridge residents was held on March 31, 1953. At that referendum the residents, by substantial majorities, voted against incorporation on January 1, 1954, and against adoption of a proposed charter.

The Commission does not regard the negative vote on incorporation at Oak Ridge as a vote against the principle of self-government or as a permanent block to incorporation at Oak Ridge. Unfortunately, it was not possible for the residents of Oak Ridge to be informed, prior to the referendum, regarding the specific terms of property sales or the nature and amount of assistance to be received from the Federal Government in the event of incorporation. Lacking such information, the residents were understandably unwilling to commit themselves to incorporation by a specified date.

Housing and Community Facilities

Savannah River

By the end of June, nearly all of the 3,508 houses programmed by the Housing and Home Finance Agency under Title IX of the National Housing Act for rental and sale had been completed. Of the total, 2,915 are for rental, and the remainder for sale.

All of the 4,500 dormitory accommodations built for construction workers have been removed. The Lyles and Lang Construction Co., builders and operators of the dormitories, has filed suit against du Pont, the AEC prime contractor, claiming the amount of $1,182,461.65 as due under its contract and an additional $107,602.58 as damages for an asserted breach of contract. The Department of Justice has undertaken the defense of the case and has filed an answer denying any liability under the complaint and a counterclaim which seeks recovery of all monies paid under the contract on the theory that the plaintiff nullified the agreement by its own acts.

Of the original 4,000 trailers providing family accommodations for construction workers, more than 1,300 had been disposed of by the end of June. This action was taken because of lack of demand resulting from the decreasing trend of construction employment. The trailers were disposed of through public sale, with the salvage proceeds credited to the Government. Trailers will be required in decreasing numbers for another 12 to 15 months.

Total Federal assistance by agencies other than AEC for facilities to the communities in the vicinity of the plant area, in addition to the programmed housing, includes $11,549,574 for schools; $2,804,100 for sewerage facilities; $2,754,261 for waterworks; $300,000 for a hospital; $492,600 for police and fire protection; and $4,326,000 for roads. Grants for the Augusta area were based on the impact of the Army's Camp Gordon as well as on the impact of the AEC's Savannah River plant. The amount for schools includes both the grants for construction of classrooms and the total amount programmed through June 30, 1953, for operation and maintenance expenses under Public Law 874.

Paducah

By the end of June, all of the 500 Title VIII permanent housing units were completed, and about 300 of the 450 permanent rental housing units programmed by the Housing and Home Finance Agency were completed. Total Federal assistance for facilities in addition to housing includes $2,797,003 for schools, $1,302,700 for sewerage facilities, and $56,869 for waterworks.

Portsmouth

More than a third of the 750 temporary units and the 1,000 permanent dwellings programmed by HHFA under Public Law 139 were under construction by the end of June. It is estimated that an additional 1,450 temporary and 1,000 permanent units may be required in order to meet the needs of construction and operating employees.

A total of $800,000 has been programmed for assistance to communities for sewerage facilities, and $319,650 has been programmed for waterworks under Public Law 139. Additional requests for assistance are being considered by HHFA.

It is estimated that at the peak of the construction program there will be 5,700 children of temporary employees and 2,069 children of permanent employees attending Portsmouth area schools as a direct result of in-migration of AEC and contractor employees. It will be necessary to provide accommodations for these children, either under an extension of Public Laws 815 and 874 or through other means.

Oak Ridge

In March, the Federal Housing Administration approved the forms of land leases to permit construction in Oak Ridge of privately financed housing under provisions of Title VIII and Title IX of the National Housing Act. A sponsor was selected for the 500 units of Title VIII housing, while the FHA issued commitments to builders for construction in Oak Ridge of 400 units of Title IX housing. A contract has been awarded for construction of a junior high school.

Richland

Of the two 500-unit Title VIII privately financed housing projects under construction in Richland, 131 units have been completed.

Los Alamos

Approval has been granted for disposal of up to 250 of the 413 housing units and 6 of the 19 barracks located at White Rock Construction Camp. This camp was established in 1948 to house construction workers engaged in the laboratory and community construction program at Los Alamos. With the decrease in construction activity a number of these units are no longer required.

Rent Control

Oak Ridge

A petition for an increase in rents under Federal rent control at Oak Ridge was filed with the Area Rent Director on March 3, 1953. The petition has not been acted upon.

Richland

The 10 percent increase in rents at Richland, placed in effect on January 1, is considered insufficient and not in conformance with rates permitted by the Housing and Rent Act of 1947, as amended. A protest, filed with the Washington, D. C., Office of Rent Stabilization on April 30, is pending.

Savannah River

Adoption of the Housing and Rent Act of 1953 served to decontrol the Savannah River trailer rents, since the trailers were constructed after February 1, 1947. The Commission is presently determining what rental rates should be established for these trailers in conformance with general Governmental policies.

Los Alamos

To comply with Bureau of the Budget regulations, surveys of utility rates at Los Alamos and utility and rental charges for AEC housing on Sandia Base were completed recently. Overall increases have been recommended at both installations and will become effective August 1, 1953.

Reactor Development

The period covered by this report included a greater number of significant events in reactor development than any previous 6 months in the Commission's history. These events indicated accelerating progress in the development of reactors for power generation, nuclear propulsion, and improved production of fissionable material.

"Breeding," or producing as much nuclear fuel as is consumed in a reactor, was successfully demonstrated in the Experimental Breeder Reactor at the National Reactor Testing Station in Idaho. This demonstration reinforced the belief that known resources of uranium may be large enough to constitute a major source of energy for many years. The Homogeneous Reactor Experiment at Oak Ridge National Laboratory generated useful amounts of electric energy while operating at its full design power. The land-based prototype of the Submarine Thermal Reactor at the National Reactor Testing Station achieved "criticality" and entered subsequent testing prior to operation at full power. The chemical plant for recovering "unburned" fissionable material from spent reactor fuel elements was placed in operation at the National Reactor Testing Station.

In addition to these achievements, the Commission developed a positive policy designed to recognize the development of economic nuclear power as a national objective. It is believed that the development of competitive nuclear power will be hastened by this policy position, which will promote and encourage free competition and private investment in development, while at the same time accepting on the part of Government certain responsibilities for furthering technical progress in this field to provide a broader basis for such development. The policy statement, which was presented to the Joint Congressional Committee on May 26, is as follows:

STATEMENT OF POLICY ON NUCLEAR POWER DEVELOPMENT

1. We believe the attainment of economically competitive nuclear power to be a goal of national importance. Reactor technology has progressed to the point where realization of this goal seems achievable in the foreseeable future if the Nation continues to support a strong development effort. It would be a major setback to the position of this country in the world to allow its present leadership in nuclear power development to pass out of its hands.
2. Accordingly, we recognize it as a responsibility of the Commission to continue research and development in this field and to promote the construction of experimental reactors which appear to contribute substantially to the power reactor art and constitute useful contributions to the design of economic units.
3. In addition, it is the conviction of the Commission that progress toward economic nuclear power can be further advanced through participation in the development program by qualified and interested groups outside the Commission.
4. We recognize the need for reasonable incentives to encourage wider participation in power reactor development and propose the following moves to attain this end:
   (*a*) Interim legislation to permit ownership and operation of nuclear power facilities by groups other than the Commission.
   (*b*) Interim legislation to permit lease or sale of fissionable material under safeguards adequate to assure national security.
   (*c*) Interim legislation which would permit owners of reactors to use and transfer fissionable and byproduct materials not purchased by the Commission, subject to regulation by the Commission in the interest of security and public safety.
   (*d*) The performance of such research and development work in Commission laboratories, relevant to specific power projects, as the Commission deems warranted in the national interest.
   (*e*) More liberal patent rights than are presently granted to outside groups as may seem appropriate to the Commission and consistent with existing law.
   (*f*) Consideration of a progressively adjusted code for safety and exclusion area requirements as may appear reasonable in the light of operational experience with reactors. Competent state authorities will be encouraged to assume increasing responsibility for safety aspects of reactor operation. Financial responsibility associated with reactor operation will be assigned to the owners, in keeping with normal industrial practice.
   (*g*) Giving full recognition to the importance of reactor technology to our national security, a progressively liberalized information policy in the power reactor field as increasing activity justifies.
5. It is the objective of this policy to further the development of nuclear plants which are economically independent of Government commitments to purchase weapons-grade plutonium.
6. We view the next few years as a period of development looking toward the realization of practical nuclear power. On this basis we conclude that the time is not yet at hand for the report called for in Section 7 (b) of the Atomic Energy Act of 1946.

Research and Testing Reactors

The Materials Testing Reactor, located at the National Reactor Testing Station in Idaho, was operated on a continuous basis. The reactor, operated by the Phillips Petroleum Co., provided irradiation facilities for more than 110 tests being performed in the reactor development program. Thirteen irradiation experiments have been completed.

Much specific information was released concerning the irradiation facilities, power level, neutron fluxes and coolant temperatures of the MTR. These data will permit the most effective utilization of the reactor for the production of special radioisotopes for unclassified use, and for the planning of unclassified basic irradiation experiments. Some significant data on the MTR are:

Design power level	30,000 kw.
Coolant	Water.
Coolant temperatures	100° F. inlet; 111° F. outlet.
Coolant flow rate	20,000 gallons per minute.
Fast neutron flux available for irradiation experiments.	1 x 10^{14} (100 million million) neutrons per square centimeter per second.
Maximum thermal neutron flux available for irradiation experiments.	4 x 10^{14} (400 million million) neutrons per square centimeter per second.

Experimental Breeder Reactor

Laboratory analyses of representative samples from the fuel elements of the core and from the natural uranium blanket that surrounds the core of the Experimental Breeder Reactor have disclosed that the amount of new fissionable material (plutonium) produced in the reactor is at least equal, taking into account chemical separation losses, to the amount of uranium 235 burned during an extended period of operation. These results confirm the belief in the feasibility of the breeding process as outlined in 1944 by a group of scientists at the Metallurgical Laboratory, operated by the University of Chicago for the Manhattan Engineer District.

The only fissionable fuel that occurs in nature is uranium 235, which constitutes less than 1 percent of normal, natural uranium. The more common form of the element—uranium 238—may be converted into plutonium in a nuclear reactor. However, until breeding was demonstrated in the EBR, scientists were not certain that plutonium could be produced in amounts equal to or greater than the fuel consumed.

The significance of the breeding process is that in theory all of the world's supply of minable uranium and thorium can be made to undergo fission.

The EBR is continuing in operation at the National Reactor Testing Station, producing more data relating to the problems associated with breeding. It was designed and is operated by Argonne National Laboratory.

Homogeneous Reactor Experiment

Successful operation of the Homogeneous Reactor Experiment at full design power, with generation of about 150 kw. of useful electricity, was accomplished on February 24 at the Oak Ridge National Laboratory. This is the second reactor to generate electricity on an experimental basis. The first electric power from nuclear energy was produced by the EBR in December 1951.

The basic purpose in building the HRE was to determine whether a circulating fuel reactor would operate smoothly. Tests have shown that the reactor operates without large nuclear fluctuations. The HRE represents an approach to nuclear power in which it is hoped that large economies may result from the use of liquid fuel, minimizing costs of fuel fabrication and chemical processing.

Experimental operation of the HRE is continuing, with the objectives of solving many remaining chemical and design problems.

NAVAL REACTORS

On March 31 it was announced that the land-based prototype of the Submarine Thermal Reactor at the National Reactor Testing Station had achieved "criticality," which means that the nuclear components of the reactor had begun to sustain a chain reaction. On May 31 the reactor first generated substantial amounts of power. Further testing and operation are continuing as the plant gradually is being brought to full power. These experiments will serve to train the crew of the USS *Nautilus*, and to determine the operating characteristics of the submarine's power plant, which will be similar to this land-based prototype. The STR is a joint Argonne National Laboratory-Westinghouse Electric Corp. project.

Submarine Intermediate Reactor

The General Electric Co., through the Knolls Atomic Power Laboratory and through subcontractors, continued construction of the land-based prototype of the Submarine Intermediate Reactor and its power plant at West Milton, N. Y. The first group of naval officers and enlisted trainees has reported for training, and will assist in the operation of the reactor and power plant. These men are the nucleus of the crew that will man the USS *Sea Wolf*, which will be powered by an SIR-type reactor.

Submarine Advanced Reactor

Design work by the Knolls Atomic Power Laboratory, with assistance from the Argonne National Laboratory, is under way for developing an advanced nuclear power plant for a submarine of significantly higher speed than the first two nuclear-powered submarines.

Large Ship Reactor

At the close of fiscal 1953 the military requirement for a prototype reactor to power a large ship was removed. However, the pressurized water design that had been considered the best approach for a ship reactor also has promise for central station power. The Commission is continuing research and development work on the pressurized water reactor.

Aircraft Reactors

Construction contracts aggregating approximately $5.5 million were awarded in March for the administration and assembly and maintenance areas for the ground test facilities at the National Reactor Testing Station in Idaho and for other facilities at Oak Ridge National Laboratory required in the program for the development of an aircraft propulsion reactor. The military requirements for an aircraft reactor have been modified and the program has been recast to develop the best possible nuclear power system.

Design and development work is continuing at the Aircraft Gas Turbine Division of the General Electric Co. at Evendale, Ohio, and at Oak Ridge National Laboratory, where work on alternate systems is being conducted. A Commission contract with Pratt and Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn., was consummated in June for aircraft nuclear propulsion development work.

Chemical Processing Plant

The new chemical processing plant at the National Reactor Testing Station, operated by the American Cyanamid Co., began operation in February. This plant was designed to recover fissionable material from used reactor fuel elements from a variety of nuclear reactors. Cost of the plant, with presently planned processing facilities, is approximately $34 million.

Industrial Participation

Condensed declassified versions of the reports submitted last summer by the first 4 industrial groups [2] studying the feasibility of power-producing reactors were prepared with the assistance of the Advisory Committee on Industrial Information. They were released publicly on May 31, and may be obtained from the U. S. Government Printing Office.[3]

Dow-Detroit Edison Group

The Dow-Detroit Edison group has increased its planned expenditures in the joint development of nuclear power which it is conducting with the AEC to more than $1 million for the calendar year 1953. This includes work being carried on by the four original companies: Dow Chemical Co., The Detroit Edison Co., The Babcock & Wilcox Co., and Nuclear Development Associates, Inc. The latter two firms have been affiliated with the study since its inception in May 1951.

Twenty-three other companies have since become associated with the group. They are contributing both trained personnel and some funds for outside research. Eleven of these companies joined the group last year. Twelve more were admitted in April 1953. The new companies are: Consolidated Gas Electric Light & Power Co., Baltimore, Md.; The Hartford Electric Light Co., Hartford, Conn.; Niagara Mohawk Power Corp., West Syracuse, N. Y.; Potomac Electric Power Co., Washington, D. C.; Rochester Gas & Electric Corp., Rochester, N. Y.; The Southern Co., New York, N. Y.; Allis-Chalmers Manufacturing Co., Milwaukee, Wis.; Bendix Aviation Corp., Detroit, Mich.; Ford Motor Co., Dearborn, Mich.; United Engineers & Constructors, Inc., Philadelphia, Pa.; Atlantic City Electric Co., Atlantic City, N. J.; and Gibbs & Cox, Inc., New York, N. Y.

Pioneer Service-Foster Wheeler Group

In March, the Commission approved the informal association of six Pioneer Service and Engineering Co. clients with the nuclear-power study being conducted by Pioneer Service and the Foster Wheeler Corp. Like the studies of the first four groups, this study

[2] Monsanto Chemical Co. and Union Electric Co., both of St. Louis; Detroit Edison Co., of Detroit, and Dow Chemical Co., of Midland, Mich.; Commonwealth Edison Co. and Public Service Co. of Northern Ill., both of Chicago; and Bechtel Corp. and Pacific Gas & Electric Co., both of San Francisco.

[3] "Reports to the U. S. Atomic Energy Commission on Nuclear Power Reactor Technology," for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 25 cents.

consists principally of a survey of the feasibility of design, construction, and operation by private industry of power-producing reactors. The Pioneer Service clients will contribute to the project financially, and in return will depend on Pioneer Service for advice concerning their position in the nuclear-power field. The six companies are: Louisville Gas & Electric Co., Louisville, Ky.; Northern States Power Co., Minneapolis, Minn.; Oklahoma Gas & Electric Co., Oklahoma City, Okla.; San Diego Gas & Electric Co., San Diego, Calif.; Oregon Power Co., Medford, Oreg.; and Wisconsin Public Service Corp., Milwaukee, Wis.

Commonwealth Edison-Public Service of Northern Illinois Group

A second report from the Commonwealth Edison-Public Service of Northern Illinois group was received early in 1953. The report covers a power reactor which differs considerably from those discussed in the first report. The CE–PS group is continuing its studies.

Monsanto Chemical-Union Electric of Missouri Group

This group has continued its conceptual design activities at approximately the same level, holding to the objective of developing a dual-purpose reactor for the production of both power and plutonium. The group has made proposals recommending pilot-plant stages, particularly of the non-nuclear mock-up type.

Bechtel-Pacific Gas and Electric Group

There has been no change in the status of this program, which rests with an offer on the part of the group to participate with the Government in the construction of a dual-purpose facility.

Zirconium Production

Carborundum Metals Co. began start-up operation in June prior to production of zirconium and hafnium in its new plant at Akron, N. Y. The AEC has contracted to buy 150,000 pounds of sponge zirconium metal each year for 5 years at a fixed price of $13.46 per pound.

Fission-Product Utilization

The Commission's fission-product utilization program continued, with the principal investigations being conducted at Brookhaven

National Laboratory, University of Chicago, Columbia University, Massachusetts Institute of Technology, University of Michigan, Rensselaer Polytechnic Institute, Stanford Research Institute, the American Meat Institute, and the Food Research Institute. It has been determined that radiation can promote certain chemical reactions, involving oxidation and halogenation. For example, benzene hexachloride has been produced in the laboratory. Indications are that polymerization of various organic compounds may be promoted by exposure to high-energy radiation of the type found in fission products from nuclear reactors. No commercially competitive processes have been developed to date, however, and these studies still are in a preliminary stage.

Research is continuing in the field of sterilization of foods by radiation. Although it has been demonstrated that radiation sterilization is possible, various problems remain to be solved before it can be considered technologically feasible or economically competitive with conventional sterilization methods.

Welding Development

The atomic energy program is a large user of type 347 stainless steel, an alloy that may be used under very corrosive conditions at high temperature. Since much of this material is fabricated by welding, the development of suitable welding materials and methods is of vital importance. Welding alloys which are presently available commercially fall into two general types. One of these is suitable for service involving severe corrosion but not for high-pressure use; the other is suitable for high pressures but not for use at high temperature or under highly corrosive conditions.

For the past year, the AEC has sponsored a program directed to the development of a welding alloy which will have the corrosion resistance of the parent metal, and at the same time remain suitable for use at high temperatures and pressures. Although this investigation has not been completed, two alloy compositions have been developed which appear very promising. On the basis of data developed to date, The Public Service Electric and Gas Co., Newark, N. J., has requested and secured permission to use samples of both of the preferred alloys in service tests involving steam at 1,150° F. and 2,700 pounds per square inch pressure. This company has conclusively demonstrated that alloys available commercially are not suitable for this service. The AEC will receive all data from the tests.

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Sanitary Engineering

Representatives of the Ohio River Valley Water Sanitation Commission visited a number of AEC facilities in the Ohio River Valley in February to study waste disposal problems associated with these plants. The water supply and waste disposal efforts and objectives of the AEC were explained to the group, which consists of Governor's representatives from the eight States in the Ohio Basin.

The United States Weather Bureau prepared a useful set of alignment charts for the calculation of diffusion of gaseous effluents into the atmosphere. These charts were published in the open literature in February.

In cooperation with the U. S. Geological Survey, which made mineralogic and petrographic analysis of natural earth materials from the National Reactor Testing Station, a policy has been established for the evaluation of radioactive waste disposal practices at the Testing Station.

Treatment of Low-Level Liquid Wastes

New York University studies of treatment of Knolls Atomic Power Laboratory laundry wastes indicate that these wastes can be treated in standard sewage treatment facilities, using trickling filters, at costs considerably lower than evaporation or other special treatments used at present. At Johns Hopkins University, related studies resulted in development of an ingenious system of rotating tubes on which will grow the zoological organisms found in trickling filter plants. Sludge digestion investigations at the University of Illinois showed that levels of activity up to 16 millicuries per liter of phosphorous 32 did not adversely affect the process. About 99 percent of the activity was concentrated in the sludge solids. A full-scale plant (the first of its kind) using the trickling filter process is being built at the National Reactor Testing Station to treat low-level liquid wastes from the central facilities laundry as well as the sanitary wastes from this area.

Gaseous Effluent Control

Investigations by Dr. C. E. Lapple, an AEC consultant, showed that deep bed fibre glass filters can be built for about half the cost of sand filters of equivalent capacity. The cost of handling separations plant offgases can thereby be reduced substantially.

Development work by A. D. Little, Inc., on all-mineral fibre filter media was completed with the successful full-scale production of a quantity of the media at the mill of the Riegel Paper Co. Results of this work will be made available to filter manufacturers and other interested persons. These media may be used in high temperature and acid conditions where cellulosic fibre would be unsuitable.

The Harvard Air Cleaning Laboratory completed two reports, "Removal of Soluble Gases and Particulates From Air Streams With Particular Reference to Fluorides," and "Air Cleaning Studies Progress Report, February to June 1952."

Basic investigations on aerosols completed at the University of Illinois included "Determination of the Drag on a Cylindrical Fiber at Low Reynolds Number," and "The Role of Particle Diffusion and Interception in Aerosol Filtration."

Combustible Wastes

Burning rates of about 120 pounds per hour were achieved in the prototype incinerator at the Bureau of Mines. Performance tests with the model unit are essentially complete. Drawings and specifications for the model are being prepared so that small units suitable for users of radioisotopes, such as universities and hospitals, can be fabricated commercially.

Ultimate Disposal of Radioactive Wastes

The feasibility of permanently fixing radioactivity within the crystal structure of natural clays has been demonstrated on a laboratory scale. Work is progressing at Brookhaven on the design of a pilot plant.

Investigation of the technical and economic aspects of sea disposal of certain radioactive waste material was started at Johns Hopkins University.

Oak Ridge School of Reactor Technology

The Oak Ridge School of Reactor Technology, now in its fourth year of operation, has scheduled an enrollment of 80 students for the 1953–54 session, which begins in September 1953. Fifty of these students were selected by a Committee on Admissions from applications submitted by industries and governmental agencies. Thirty recent graduates from colleges and universities were selected to attend as employee-students of the Oak Ridge National Laboratory.

When the 1952–53 session ends in August, over 200 alumni of

ORSORT will be employed in 60 industries or Government agencies engaged in various phases of reactor design and development.

The experienced engineers and scientists who will attend the next session under sponsorship of their employers represent industry or the Government as follows, some employers sponsoring more than one student: Aerojet Engineering Corp.; Allis-Chalmers Manufacturing Co.; American Cyanamid Co.; American Gas & Electric Service Corp.; American Locomotive Co.; American Machine & Foundry Co.; Department of the Army, Office of the Chief of Ordnance; Department of the Army, Office of the Chief of Engineers; U. S. AEC Naval Reactors Branch; Babcock & Wilcox Co.; Bethlehem Steel Co.; Boeing Airplane Co.; Department of the Navy, Bureau of Ships; California Research & Development Co.; Curtiss-Wright Corp., Wright Aeronautical Division; E. I. du Pont de Nemours & Co., Inc.; Electric Boat Division of General Dynamics Corp.; the Fluor Corp., Ltd.; Foster Wheeler Corp.; General Electric Co.; The Goodyear Tire & Rubber Co.; Merck & Co., Inc.; Naval Research Laboratory; Newport News Shipbuilding & Dry Dock Co.; Pratt & Whitney Aircraft Division of United Aircraft Corp.; Southern Services Inc.; Tennessee Valley Authority; United States Air Force Institute of Technology; and Westinghouse Electric Corp.

Physical Research

Among the major objectives of the Commission's physical research program are the improvement of the processes used in present operations and the broadening of the scientific basis for new potentialities in the use of atomic energy. Basic research is financed by the AEC in universities, private research institutions, and in the national laboratories. The national laboratories also carry the major responsibility for solving problems which have an immediate bearing on current operations of the atomic energy program.

This section briefly describes typical unclassified studies, such as those for determining the chemical and physical properties of new materials for use in reactors, and those which seek improved methods for the chemical separation of fission products from reactor fuels or uranium from its ores. This section also describes studies of the behavior of subnuclear particles which are being undertaken to provide better understanding of the energy stored in the atomic nucleus. Progress is recounted in the construction of research facilities and in the development of private interest in research reactors.

Research on Reactor Materials

Ceramics

The demand in the field of nuclear energy for new materials with unusual properties has stimulated interest in ceramics. Some ceramic materials, such as graphite, beryllium oxide, and Portland cement, are used as moderators or for shielding purposes in many of the nuclear reactors now in operation. Others are useful as containers for processing metals required in the construction and operation of reactors. Ceramics research and development centers have been organized at Oak Ridge and Argonne National Laboratories. Specialized equipment has been assembled for obtaining engineering data on these materials. Measurements of interest to reactor technology relate to the physical, chemical, and mechanical properties of ceramic materials at high temperatures and under intense irradiation. Results will be useful for the design of high performance reactors operating at elevated temperatures. Included in this class are the so-called "package reactors" which might be developed for nuclear power production in remote areas, as well as reactors for propulsion of ships and aircraft.

The group at Oak Ridge is studying pure oxides, borides, nitrides, carbides, ceramic-metal combinations (cermets), and other ceramic materials. The Ames Laboratory is specializing in the preparation of crucible materials for the melting and casting of metals. Argonne National Laboratory and Battelle Memorial Institute are exploring the properties of a number of oxides, nitrides and carbides in combination with various metals as refractory compounds potentially useful in reactor construction. Other fundamental investigations of ceramic materials are supported at the University of Alabama, the University of California, Massachusetts Institute of Technology and North Carolina State College.

Corrosion

The application of atomic energy requires the use of unconventional materials at temperatures beyond the range of previous industrial experience. Under such conditions corrosion becomes an acute problem. The physical research program includes studies of the basic nature and underlying causes of corrosion with the objective of reducing it in specific situations.

Argonne National Laboratory is engaged in basic studies of the corrosion of aluminum, zirconium and uranium alloys in dilute aqueous solutions at various temperatures. Subsequently, other metals of value as reactor components will be investigated. Scientists at Battelle are studying the surface reaction rates of hydrogen, oxygen and nitrogen with zirconium, titanium, vanadium, thorium and niobium.

Until recently, zirconium was a little-used and little-known metal. Its properties still are not completely understood. Since it now is coming into extensive use in reactors, fundamental investigations of its corrosion are being made. Pennsylvania State College is studying the theory of the corrosion of zirconium, with particular emphasis on the effect of impurities and the use of halides as corrosion inhibitors. Case Institute of Technology is investigating the fundamental nature and cause of the corrosion or scaling of zirconium in air at elevated temperatures. The University of Oregon has a research program on the electrochemistry of zirconium and zirconium alloys in different aqueous media.

Separation Chemistry

In any reactor the fission products, or "ashes," ultimately have to be removed to allow the fission process to continue. In pure form these radioactive byproducts of the reactor operation are useful sources of radiation. Therefore, chemical processes are required for the separation and purification of the fission products, as well as for the recovery of the unused fissionable material. Oak Ridge National Laboratory, Knolls Atomic Power Laboratory, and Argonne National Laboratory have been developing such processes, specializing in the fundamentals of ion exchange, solvent extraction and other methods for the separation of these materials.

In the more extensive field of separation chemistry, these laboratories are interested not only in improving processes presently in use for operations such as the extraction of plutonium from irradiated fuel, or the recovery of uranium from its ore, but also are looking toward the development of new and more economical processes. For example, ORNL developed the process used in the new chemical plant at the National Reactor Testing Station in Idaho. KAPL, in addition to developing equipment for the Savannah River separations plant, has made extensive pilot plant tests on the complete separations flow sheet. ANL developed the separation methods to be used in the recovery of spent fuel for the Submarine Thermal Reactor.

Other AEC laboratories also work on separation chemistry as it pertains to their own programs, and many university contractors are contributing fundamental studies in inorganic and physical chemistry which bear directly upon the separations processes. One of the most widely used processes involves a liquid extraction column, and it has been necessary to study the underlying principles which determine the extent of the extraction. Various phases of this problem are being studied by chemists at the University of Kansas, North Carolina State College, Oklahoma A. & M. College, Virginia Polytechnic Institute, and other universities. The knowledge thus obtained is making it increasingly possible to achieve more economical and efficient methods for the separation and purification of materials used in the atomic energy program.

Radium Separation

A new, faster, and more efficient way to obtain pure radium from a mixture of the elements radium and barium has been devised by scientists at Mound Laboratory.

Barium and radium occur together in nature, and are very difficult to separate because of their chemical similarity. The separation method used commercially today was first used by Marie and Pierre Curie in 1898.

The Curies employed a laborious method of separating these elements called fractional crystallization. They dissolved a mixture of the chlorides (or bromides) of radium and barium in hot water. As the water cooled, a solid was formed which contained more of the radium than the solution. When this solid was redissolved in hot water, purer radium was deposited in the solid. Repetition of this procedure 23 times during the course of a month gave the Curies nearly pure radium.

Scientists at Mound developed a method using a solid which would carry more of the radium from solution in a shorter time. The solid they used was radium-barium chromate and the method is known as precipitation from homogeneous solution. They were able to purify the same amount of radium as the Curies in about 10 steps, which can be carried out in a few days.

RAW MATERIALS RESEARCH

As noted on page 8, the AEC is increasing its efforts to develop economic methods of recovering uranium from domestic low-grade ores such as phosphates and shales. Basic studies of the physical research program are providing long-range fundamental support of this effort.

Chattanooga shales are being studied at Pennsylvania State College and at the University of Tennessee. Investigators at Pennsylvania State are attempting to determine the composition, distribution and relative proportions of the constitutents of these shales, the manner in which uranium is associated with these compounds, and the variation of uranium content in comparison with that of other trace elements in the shales. Another group at Pennsylvania State is attempting to determine whether uranium is associated with the organic matter in the shales, and, if so, the nature of the chemical association.

The University of Tennessee is studying the genesis of the Chattanooga shales with emphasis on stratigraphic relationships and their implications. This work includes a systematic collection of samples of shales for chemical assay and study of geologic structures. Results are coordinated with the mineralogic studies of Pennsylvania State College.

Basic investigations related to the extraction of the uranium from low-grade sources, such as the Florida phosphates, are being made at Columbia University and at Oak Ridge National Laboratory. The Columbia group is concerned with phosphate slimes, which are extremely stable suspensions of fine particles in water. They contain uranium, but are difficult to process because of their low rates of filtration or sedimentation. Scientists at Columbia University are trying to devise a means of dewatering the slimes so that they can be handled economically for extraction of the uranium. A group at ORNL is investigating the behavior of uranium in phosphate solutions and is studying solvent extraction in the phosphate system. The group already has developed an experimental method for the recovery of uranium from the presently unused submarginal material covering the phosphate rock structure in Florida.

High Energy Research

Experiments have yet to reveal the basic role in the structure of the nucleus played by the newly discovered subnuclear particles called mesons. Some of these particles are found in cosmic radiation, and some have been produced from the collisions of high speed particles from the largest accelerators. Most mesons have masses intermediate between the proton and the electron, although some are heavier than the proton. Some are charged positively, some negatively, and some have no charge at all. All those discovered thus far have a short life, after which they transform into other mesons or into the better known particles, such as protons, electrons or gamma rays.

It is clear that these unstable particles must be taken into account in the theory of the nucleus, but first such fundamental properties as their masses, charges and lifetimes must be known. The problem of the nucleus has become more difficult to solve because of the large number of mesons which have been discovered. Apparently the end of such discoveries has not yet been reached. Research in this field is continuing under several contractors of the joint AEC-Office of Naval Research program and under AEC sponsorship at Brookhaven National Laboratory, University of California Radiation Laboratory, California Institute of Technology, Carnegie Institute of Technology, University of Michigan, Purdue University, and the University of Rochester.

Appendix 6 lists the unstable elementary particles known at present.

Research Tools

In order to obtain a better understanding of nuclear energy and the structure of the atomic nucleus, scientists need machines to accelerate charged particles to high energies, as well as nuclear reactors and low-energy particle accelerators to provide sources of neutrons. Under controlled conditions and on a laboratory scale, these instruments produce the same reactions that take place in the large-scale release of nuclear energy in fission and other reactions. In order to translate the results of such laboratory experiments into predictions of performance of weapons and reactors, electronic computers must be used to solve complex mathematical problems. There is, therefore, a continuing need for new research tools in the atomic energy program.

During the past six months, plans were made for additional shielding around some of the existing high-energy accelerators, a new linear accelerator neared completion, and plans were made to purchase an additional Van de Graaff accelerator. An increased effort for the development of new accelerators has grown out of the discovery of the alternating-gradient focusing principle. Groups outside of the AEC are continuing to show interest in acquiring low-power research reactors. A computing facility is now in use to help meet the computational needs of the AEC and its university contractors.

Particle Accelerators

The results of the tests on the cosmotron at the Brookhaven National Laboratory will be valuable in the operation of the bevatron at the University of California Radiation Laboratory. Information has been obtained from Brookhaven on which to base a preliminary estimate of the shielding required for the bevatron, which is expected to go into operation in late 1953. This machine is designed to accelerate protons up to 6 Bev (billion electron volts).

Studies of the radiation intensities around the synchrocyclotron at the Carnegie Institute of Technology indicate that additional shielding will be required as a result of improvements now being made in the oscillator. These changes are planned to increase the proton beam current by a factor of about 10. The machine accelerates particles to an energy of 420 Mev (million electron volts). Additional shielding also will be required for the synchrocyclotron at the University of Rochester.

The building which will house the linear electron accelerator at Yale University is nearly completed. The construction and installation of the accelerator and the associated neutron cross-section-measurement equipment will be completed in the fall of 1953. This 20-Mev machine will be used as a high resolution time-of-flight velocity selector for neutron cross-section measurements.

The AEC has authorized a 6-Mev Van de Graaff accelerator for Columbia University. This machine will be purchased from the High Voltage Engineering Corp. and delivered to Columbia in late 1954. It will be used for studies in neutron physics and charged particle cross-section measurements.

The alternating-gradient principle for focusing charged particles has been tested experimentally by the AEC at the University of California Radiation Laboratory and at Oak Ridge, and independently in Niels Bohr's laboratory in Denmark. Scientists at the Radiation Laboratory have focused the beam of the 40-foot linear proton accelerator, which resulted in a considerable increase in the output current density.

Application of the alternating-gradient focusing principle, which results in confining of charged particles to a beam of unusually small cross section, may make possible the construction of very high-energy accelerators at lower cost. The higher energies available with such machines not only will allow investigators to probe still deeper into the nature of matter, but also may result in practical applications in such fields as radiography and radiation therapy.

In view of the promising possibilities, $250,000 was added to the Commission's accelerator program for studies looking toward the possible construction of accelerators in the 10–100 Bev range. Planning for the construction of such high-energy proton synchrotrons is proceeding at Brookhaven, with the help of Princeton University, Harvard University, and Massachusetts Institute of Technology, and among a group of midwest universities participating in the Argonne program.

Stanford University is investigating the ultimate limitations of the device known as the traveling-wave linear electron accelerator. A 1-Bev electron linear accelerator, which went into service in December 1952, is being used in these AEC-sponsored studies. It was constructed under a joint AEC-Office of Naval Research program.

One objective of the project is the development of conceptual design studies of linear accelerators for still higher energies.

The heavy-particle cyclotron at the Oak Ridge National Laboratory is now being used to accelerate large currents of triply charged nitrogen ions. The nuclei of 9 light elements between hydrogen and sulfur were bombarded with the 25-Mev nitrogen ions produced in this 63-inch cyclotron. More than 20 new nuclear reactions have been observed and their average cross sections determined. Many of these are new types of reactions, previously unreported, including reactions in which nitrogen nuclei combine with nuclei of such elements as carbon, oxygen, and sulfur to produce the much heavier nuclei of sodium, aluminum, and scandium.

A new record ion current for cyclotrons was achieved with the 86-inch cyclotron at the Oak Ridge National Laboratory. A proton current of 3 milliamperes at 22-Mev was obtained, with an overall electrical efficiency of 19 percent. Several new isotypes have been discovered with this machine. Five new radioisotopes (of gallium, potassium, dysprosium, erbium, and thulium) have been definitely identified. In a study of nuclear structure and nuclear diffraction effects, measurements have been made of the angular distributions of 22-Mev protons elastically scattered by 15 different elements from beryllium to thorium.

Research and Training Reactors

During the past 6 months, universities have shown continued interest in acquiring reactors for use in research and in the training of students. Through no-fund contracts, the AEC is cooperating with several institutions which have requested information to aid them in the design of low-powered reactors for this purpose. Case Institute of Technology, the University of Michigan, and Pennsylvania State College are making design studies in order to present detailed proposals for the construction of research reactors. Other universities also have made preliminary inquiries indicating interest in constructing small research reactors.

The new Argonne Research Reactor is nearing completion at Argonne National Laboratory. The loading of the reactor with fuel is expected to begin in August. The Argonne Research Reactor was built to replace the CP–3 Prime Reactor, which will be dismantled when the new reactor is in full operation. The land occupied by the CP–3 Prime Reactor and associated facilities will be turned back to the Forest Preserve District of Cook County, from which it was leased during World War II by the Manhattan Engineer District.

Only one privately owned research reactor is in existence at present. It was financed, constructed, and housed by the Consolidated University of North Carolina. Arrangements are being made by the Commission to supply enriched uranium fuel for this reactor.

Electronic Computers

A UNIVAC electronic computer has been installed in a building near Washington Square in New York City, where it will be operated for the AEC by New York University. The computer began full operation about June 1. Fifty-one AEC or joint AEC-Office of Naval Research contractors have been informed that after July 1, 1953, about 10 percent of the useful UNIVAC computing time at NYU will be available for computations of importance to the basic research interests of AEC. The rest of the available time will be devoted to the immediate programmatic needs of the AEC.

Construction of two other computers, the AVIDAC and the ORACLE, at Argonne is essentially complete. The AVIDAC has been used to solve several problems, and it is expected that the ORACLE will be shipped to Oak Ridge late in the summer for use by Oak Ridge National Laboratory.

Biology and Medicine

The Atomic Energy Act directs the Commission to protect the health of persons in the atomic energy program during research and production activities and to utilize atomic energy to improve the public welfare and to increase the standard of living. To further these objectives, the Act authorizes and directs the Commission to conduct a research program in which fissionable and radioactive materials are utilized for medical, biological and health purposes.

Research under the biomedical program covers all types of studies designed specifically to reveal more about basic changes which the body undergoes as the result of radiation injury or disease. Some of the related studies have an important role in contributing fundamental knowledge basic to the release, effects, and utilization of atomic energy. This section summarizes a few recent developments in the research program in the field of biology and medicine, with particular reference to the Commission's cancer research program.

CONSTRUCTION OF RESEARCH FACILITIES

Since the inception of the biology and medicine program in 1948, research facilities totalling $25 million have been constructed. The dedication of the Argonne Cancer Research Hospital on March 14, 1953, marks the substantial completion of this program. No new major additions are planned for the coming fiscal year.

Biomedical Research Laboratory—Los Alamos Scientific Laboratory

The laboratory was 86 percent complete at the end of April, with total costs estimated at $2,283,000.

Argonne Cancer Research Hospital, Chicago

Completion and occupancy were accomplished in December 1952. Total cost was estimated at $4,180,000. The Argonne Cancer Research Hospital is the largest facility ever designed and built specifically for the purpose of applying atomic energy to the diagnosis, study, and treatment of cancer and closely allied disorders. The dedication of this center marks the fifth year of operation of the Commission's cancer program. A brief description of this unique research center is included on page 39.

CANCER RESEARCH PROGRAM

The Commission's cancer research program was begun early in 1948 under the stimulus of action by the Eightieth Congress in making the initial appropriation implementing the Atomic Energy Act. In its appropriation for fiscal 1948, the Congress made available to the Commission for cancer research work "such sums (not exceeding $5 million) as the Commission believes can be used efficiently without duplicating research work of other public and private agencies." In connection with the authorization by Congress to engage in cancer research, two significant facts should be noted: (a) the Commission's program is one of research and not clinical treatment; only a limited number of patients are treated; and (b) in order to avoid duplicating or repetition of efforts of other Government agencies and private foundations, the program is focused upon the unique tools and products of atomic energy—such as atomic reactors and radioisotopes—and their application to cancer treatment.

In subsequent years, the Commission has continued to support cancer research, both in its own facilities and at universities and other institutions. In December of 1951, the Advisory Committee for Biology and Medicine (see Appendix 2) wrote to the Chairman of the Atomic Energy Commission: "Cancer is a specific industrial hazard of the atomic energy business. This significant fact justifies, in the opinion of the committee, the continued exploitation of the Commission's special facilities for radiation in cancer research, diagnosis, and therapy. The committee recommends the cancer program be vigorously pursued as a humanitarian duty to the nation." The Commission's reply stated: "We are reminded, too, that in juxtaposition to the very radiation which can contribute to cancerous reactions in living tissue, radioisotopes and controlled irradiation with neutrons hold promise of being among the most effective means yet devised for the study and treatment of cancer."

More recently Dr. Shields Warren, former Director of the AEC Division of Biology and Medicine, and now a member of the Advisory Committee for Biology and Medicine, summed up the Commission's cancer program in these words at the dedication of the Argonne Cancer Research Hospital: "In establishing its program in cancer research, the Atomic Energy Commission recognized that private philanthropy and public social conscience have already made significant advances in the struggle against cancer, and that its program should complement rather than compete with existing efforts. This it has done, and is turning toward human well-being its tremendously powerful sources of radiation and tools for research."

The primary purpose of the Commission's biomedical program is the study of possible effects of the various kinds of ionizing radiations for the protection of workers employed in atomic energy activities. Much of the mainline portions of this program, however, are concentrated on ionizing radiations as a cause of cancer. The knowledge gained through this program has direct application to cancer control and to research designed to learn the nature and evolution of cancer in experimental animals. Consequently, the Argonne National Laboratory, the AEC project at the University of Rochester, and the Los Alamos Scientific Laboratory, among others, as byproducts of their radiobiological programs, are accumulating a wealth of data on the effects of a variety of radioactive materials, with particular reference to the circumstances under which they are most apt to produce cancer.

The Commission's program of research in the study, diagnosis, and treatment of cancer essentially falls within three categories: (a) investigations being carried out at National Laboratories or major facilities; (b) "off-site" studies being supported by the Commission at certain universities, hospitals, or research centers utilizing unique applications of atomic energy; and (c) the distribution of radioactive isotopes for cancer studies. The work under the first part of this program is conducted at four major AEC cancer research centers, located at Brookhaven National Laboratory, Oak Ridge Cancer Hospital, Argonne Cancer Research Hospital, and at the Radiological Laboratory at the University of California Medical Center, San Francisco.

The Argonne Cancer Research Hospital

The newest and largest of these 4 facilities is the Argonne Cancer Research Hospital in Chicago. Built and equipped by the AEC, this center is being operated for the Commission by the University of Chicago. The hospital consists of 6 floors, a basement, and a subbasement. Two floors are for patient care, providing beds for 56 patients. The remainder of the building houses numerous radiation devices and laboratories, including powerful radiation sources.

A 2-million volt Van de Graaff generator will be used for rotational therapy and for studies of the effects of super voltage X–ray on cancer. A linear accelerator will be used to accelerate electrons to energies up to 50 million electron volts, sufficient to allow them to pass easily through the body. Other equipment will include a rotational therapy machine employing a 1,800-curie source of cobalt 60. The University of Chicago's 450-million volt proton synchrocyclotron already is completed and will be made available for use by the hospital research staff. Standard X-ray facilities and radioactive isotopes also will be available. These sources will enable the hospital to utilize all types of ionizing radiation now thought to have possible value in cancer therapy, excepting only pile-generated neutrons.

Facilities of the hospital are available not only to the Argonne National Laboratory, but also to the 32 universities and research institutions in the Midwest which are participating members of the laboratory. The hospital will be used solely for cancer research; not for the treatment of other diseases nor for the routine treatment of cancer by methods already established.

Brookhaven National Laboratory

The atomic pile at Brookhaven National Laboratory is being used in the treatment and study of cancer. The line of attack here is to develop a technique of irradiating deep-seated brain tumors, utilizing a neutron capture reaction in order to destroy the cancer without damaging healthy tissue surrounding it. The treatment begins with injection of a solution of borate, compounded from boron 10, into the patient's bloodstream. The patient is placed in such a position that the tumor is exposed to a beam of neutrons from the pile. As the neutrons reach the tumor, they are captured by the boron atoms, which break down, emitting alpha particles. It is these alpha radiations which destroy the tumor cells.

The response of some of the patients to this treatment has been impressive, although the improvement in all cases has been temporary. Ten patients have been irradiated. All of the cases treated at Brookhaven have been considered terminal cases by their physicians. Unfortunately, none of the cases to date were cured, but in the more favorable cases about 6 months of useful time was added to the patients' life spans. Periods of observation of up to 6 months have revealed no serious complications resulting from this form of treatment. Before adequate control of tumor growth can be expected, a great deal more information must be obtained on the rate of distribution of the boron through the tumor mass, and further instrumentation must be developed to provide more accurate information as to the total integrated dose given to the tumor.

Cancer Studies at Oak Ridge

The Oak Ridge Cancer Unit was developed in cooperation with the Oak Ridge Institute of Nuclear Studies. The hospital contains 28 beds plus research laboratories. Research activities are aimed at exploiting pile-made isotopes immediately available at Oak Ridge. Special emphasis is being placed on pioneer studies with isotopes never before used in medicine and on the very short-lived isotopes which cannot be utilized at distances from the source. The facility is oriented towards residency training of physicians from southern medical school hospitals in the use of isotopes for treatment of cancer.

The Oak Ridge group has actively pioneered in the development of cobalt 60 teletherapy units. These devices, using highly active radioisotope sources, are so designed that a beam of radiation may be directed into the body from the outside, as a form of treatment for certain malignant tumors. Teletherapy has proven beneficial in treating deep-seated cancers. It offers the advantage of requiring relatively small sources, enabling the irradiation to be better concentrated on the tumor mass and reducing the irradiation of surrounding healthy tissue. Cobalt 60 units now are in use or planned for use in many treatment centers throughout the country. More recently the Oak Ridge group has been working on other types of sources for teletherapy, notably cesium 137.

University of California Medical Center

At the University of California Medical Center in San Francisco, a radiological laboratory has been built and equipped with funds supplied by the Commission. Housed in this laboratory is a 17-ton synchrotron for the treatment of cancer patients. This unit, capable of producing a beam of ionizing radiation, either X-rays or high-speed electrons, ranging in energy from 5 to 70 million electron volts, has recently been completed, and experiments are now under way on the irradiation of various biological systems. Treatment of patients has not yet commenced, pending the results of these preliminary experiments. The synchrotron is capable of delivering powerful X-ray beams on cancer deep within the body with less dosage to surrounding tissue than is possible with lower voltage equipment. The group at the Radiological Laboratory also has investigated methods of treatment of thyroid cancer by use of radioactive iodine (I–131).

Off-site Cancer Research

In addition to research at Commission facilities, the AEC supports cancer research at various universities and medical schools. These studies involve unique applications of atomic energy developments to cancer, such as the attempts to use the annihilation-of-matter reaction from positron emitters in the diagnosis of brain tumors, the use of radiogold in interstitial therapy, and the use of cobalt 60 in needles and seeds in place of the more expensive radium. It is believed that all of these activities, in achieving their objectives in cancer research, will pay dividends in the form of added knowledge concerning the biological effects of ionizing radiation.

Support also is given to fundamental work at schools and research institutes in their cancer research programs. Such basic studies are supported, not because they involve direct applications of atomic energy to the cancer problem, but because of a need for more fundamental knowledge in such areas as nucleoprotein metabolism, lipid metabolism, and the like, at the cellular level. Without this knowledge we cannot hope to understand the complex chain of events following the exposure of living matter to ionizing radiation.

In order to stimulate exploration of methods of using radioisotopes in cancer study, diagnosis, and treatment, the Commission in 1948 undertook a program of distribution of radioisotopes for these purposes free of production costs. Since July 1, 1952, a charge of 20 percent of production costs has been made. Today, radioactive isotopes of common elements are being used more and more

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extensively in the treatment of cancer. They may be given internally, either directly into the bloodstream, as with phosphorus 32, or by mouth, as with radioiodine, or they may be injected directly into the tumor. The effectiveness of this type of therapy depends on whether or not the radioactive isotopes can be concentrated in the cancer tissue appreciably more than in adjacent normal tissues.

Radioiodine has proved of limited but real value in treating thyroid cancer. Phosphorus 32 is probably the drug of choice in treating Polycythemia Vera, a disease of the red blood cells. It has proved beneficial as an adjunct treatment in various of the leukemias and in Hodgkin's disease and lymphosarcoma. Radiogold has been used experimentally in tumors by injection directly into the tumor mass and by local injection into the abdomen in the treatment of the accumulation of fluid associated with generalized cancer within the abdominal cavity. Although this does not seem to cure the cancer, it tends to reduce the fluid accumulation and in many cases gives the patient a great deal of relief from abdominal distress. The results of using radiogold by injection directly into prostatic cancers are encouraging, although this technique is a relatively new one.

It is too soon as yet to offer conclusions concerning the ultimate role of atomic energy in the problem of the control and cure of cancer. Although a greater variety of bigger and better sources of ionizing radiations may not prove to be the final answer to the cancer problem, such sources are proving themselves to be valuable experimental and therapeutic tools. Treatment is limited by the degree of damage which may be produced in intervening and nearby normal tissues. Therefore, it would appear that considerable research is indicated in advancing methods to concentrate the ionizing radiations in cancerous tissues. Eventually, the greatest value of the application of atomic energy to medical and biological problems may well be found in the exploitation for research of radioisotopes of the elements which normally make up living matter. In this manner, atomic energy is certain to aid in the solution of many problems associated with cancer.

Current Medical and Biological Research Activities

In addition to work undertaken at its National Laboratories and major research facilities, the Commission supports an estimated 360 "off-site" research projects in the fields of cancer, medicine, biology, and biophysics. These studies are initiated through contract arrangements with universities, colleges, hospitals, and other research laboratories throughout the country. Under the 1953 budget, about $7 million was allocated for this research work. Approximately $5.8

million of this sum was allocated for the renewal of about 285 existing projects, and $1.2 million for support of new research studies. Some of these investigations are reported below.

Protective Action of Fatty Acids

Studies under way at the University of Southern California indicate that fat in the diet is essential for normal resistance to X-irradiation. Experiments have shown that when the diets of rats included cottonseed oil, survival time following repeated sublethal doses of 300 roentgens of X-irradiation was far greater than for animals whose diets did not include fat. Further examination showed that the protective action was provided by methyl linoleate, a normal constituent of many fats and oils and an essential constituent of the diet. As little as 10 milligrams per day afforded significant protection against X-irradiation damage.

It appears that the protective action may be related to metabolism of the skin, since it is known that highly unsaturated fatty acids, such as linoleate, play an important part in skin metabolism.

Study of Alpha Radiation

At the Radiation Laboratory of the University of California, experiments are being conducted with animals to ascertain the effects of alpha particle irradiation upon the eye for possible use as a treatment for intra-ocular cysts. Injections of less than a millicurie of radioactive astatine into the anterior chamber of the eyes of animals left the eyes far too quickly to be used as an effective treatment. However, the astatine passed into the blood stream and from there was taken up by the thyroid gland, producing almost complete destruction of the thyroid tissue. As a result one of the animals developed characteristic myxoedema or hypothyroidism. When this animal was placed on a diet of thyroid substance in milk, the animal rapidly returned to normal activity.

Alpha Emitter Concentrations in Body

At Mound Laboratory, investigations are being made with laboratory animals to determine the lowest concentrations in the body of certain alpha-emitting elements which will harm organs and tissues. Through these long-term studies, maximum permissible concentrations of certain elements in the human body may be reevaluated, especially in connection with possible exposure of workers in plants and laboratories. Also, these experiments will make it possible to determine the so-called "critical organ," the most important vital organ eventually affected adversely by exposure to minute quantities of alpha-emitting materials. Mound scientists also are identifying a variety of chemical substances which behave like alpha-emitters in reducing cell division without simultaneously retarding cell growth.

Life-span and Work Capacity

Most of the studies conducted to date regarding the effects of radiation on longevity and work capacity of animals have been on a short-term basis. This has been partially due to unfavorable climatic conditions in certain areas and the inadequacy of existing outdoor facilities. To provide facilities for long-term research in this field, a contract was initiated with the University of California at Davis, Calif., for construction of an outdoor installation which will accommodate 300 dogs. These facilities, which were partially completed in January, will be operated by the School of Veterinary Medicine of the University. The climatic conditions are ideally suited for animal experiments, and maintenance cost will be relatively low, since no heating will be necessary.

The radiation doses employed for these studies will range from 100 to 300 roentgens, administered at various time intervals. A suitable number of animals will be used as controls. Data obtained will guide investigations of other animals.

A breeding colony will be maintained for producing dogs for experimental uses on the project, and for the use of animals at other laboratories of the Commission or universities. It is expected that the group will obtain valuable incidental information on canine diseases, parasitology, and nutrition.

Study of Chemical Processes

Since ionizing radiations cause chemical changes in living cells, basic studies of the chemical composition of living matter and chemical reactions are essential for the understanding of radiation effects. One of the most important ingredients of living material affected by ionizing radiation is the nucleic acid component. A new line of attack on the structure of nucleic acids recently was developed by a research group at Washington University, St. Louis, Mo. By splitting the complex molecules of nucleic acid in a methanol medium, the investigators have been able to determine the incidence of certain terminal groups and cross-linkages, which are not separable by simple hydrolytic procedures.

Related studies also include research with a variety of phosphorylated compounds. Synthesis of these particular compounds previously was handicapped by sensitivity of parts of the molecule to changes in hydrogen ion concentration and other factors complicating the use of aqueous solutions. The Washington University group has developed a method which promises to circumvent these difficulties through the use of free-radical preparations in ethers.

Somatic Mutation Program

In cooperation with various agricultural experiment stations, Brookhaven National Laboratory early in 1952 began to use its gamma radiation field for the induction of mutations in fruit trees and other plants of agricultural importance. The value of this program has been widely recognized, and already a number of eastern experiment stations have sent trees and shrubs to the laboratory. Trees or shrubs ranging in age from seedlings to mature flowering plants have been set out in the field, where they are exposed to continuous radiation, the dosage received depending on the distance from the cobalt 60 source. Mutations induced by the radioactivity may be expected to appear in buds at any level of growth of the tree or plant. Later, cuttings can be transferred as scions to nonradiated plants at the home agricultural stations. It is hoped that such large scale irradiation of many different kinds of trees and plants will develop new and commercially valuable varieties. Mutations also may be expected in the seeds, but it takes much longer to grow and test these germinal mutations than the somatic variants.

Detection and Treatment of Brain Tumors

The Department of Neurosurgery at the Massachusetts General Hospital in Boston has made considerable progress in the development of instruments and techniques to aid in the external localization of brain tumors through the use of radioisotopes. Detailed studies have been made of the metabolism of positron-emitting isotopes in both tumorous and normal tissue of animals. When radioactive isotopes are administered intravenously, they concentrate in cancerous and normal tissue in varying ratios. An appreciably higher concentration in the tumor mass enables the investigators to locate the tumor mass within the head with newly developed detection instruments. This technique is expected to be of much value in diagnosis and treatment of brain tumors or other diseased tissues imbedded in critical areas of the body.

Another development involving the application of ionizing radiation in the possible treatment of brain tumors was reported recently by the research group at Northwestern University Medical School in Chicago. Small pieces of absorbable gel, impregnated with radioactive colloidal gold or chromic phosphate, were implanted in the brain tissue of 50 animals. Following sacrifice of a limited number of animals, a 1–3 millimeter zone of dead tissue was found surrounding the site of implantation. After several weeks, however, it was discovered that the dead tissue in the remaining animals was replaced by regenerating tissue, and the only effects detectable were those of surgical trauma. These results suggest the possible therapeutic application of radioactive gold or chromic phosphate to insure complete eradication of diseased tissue following brain surgery.

Use of Fission Products for Control of Trichinosis

Investigators at the University of Michigan have been studying the radiosensitivity of the trichina larva. The larvae were exposed to radiation both in infected pork or rat muscle and after removal to tap water. Impractically high doses were required to immobilize the larvae completely, but only about 5,000 roentgens of X-rays or 10,000 roentgens of cobalt 60 radiations were sufficient in most instances to prevent the larvae from maturing to adult forms and reproducing after they had been ingested by rats. Examination of adult female parasites which had been subjected as larvae to the cobalt 60 gamma ray dosages showed complete disorganization of the sexual apparatus. It is hoped that these studies may lead to a practical use of ionizing radiation in contributing to the control of human trichinosis, an important public health problem.

Total Body Scintillation Counter for Human Subjects

The Los Alamos Scientific Laboratory has developed a large scintillation counter for recording the total body load of radioactivity. The subject is placed within the cylindrical counter, so that essentially all emanations arising from radioactive disintegrations anywhere in the body are recorded. The instrument is sufficiently sensitive to measure even the low level of radioactivity naturally present in the tissues of persons who never have been exposed to any particularly radioactive materials. Any appreciable increase in activity above this natural level is easily detected.

Heart Action Studies

Tulane University investigators have developed a novel technique for analysis of the fundamental processes in heart action. The heart of a turtle, previously injected with tracer potassium, is removed from the animal and connected to a pipeline which provides a constant supply of a physiological salt solution. As the heart beats, some of the radioactive potassium ions are released from the heart muscle cells into the coronary circulation and are carried out by the circulating fluid. A special apparatus, called an "effluograph," collects this fluid on a moving paper strip, with sufficient resolution that as many as 17 samples per second may be separated for counting the radioactivity of the released potassium isotope.

This technique has provided the first means of tracing the release of potassium accompanying a single contraction of the heart. The time-course of the potassium release is being correlated with that of the electrocardiogram and of the heart contraction itself in an effort to achieve a better understanding of the basic processes which connect these three aspects of the heart's action. The investigators hope to extend these studies to mammalian hearts and to the behavior of biologically active ions other than potassium. The action of cardiac drugs also may be studied by this technique.

Improved Diagnostic Procedure

At the University of California Medical Center Radiological Laboratory, a group has developed a new diagnostic procedure utilizing the radioisotopic iodine thyroid function test. This procedure appears very promising in the differentiation of types of thyroid failure in infants and children. The method involves a comparison of iodine 131 uptake by the thyroid before and after the administration of the thyrotropic hormone (the pituitary hormone controlling the activity of the thyroid gland). In patients with thyroid deficiency resulting from insufficiency of the pituitary gland, the administration of the thyrotropic hormone produces an appreciable increase in uptake of iodine 131 by the thyroid. The increase is much less in cases in which the deficiency is in the thyroid gland itself. Only a small number of patients have been compared in this manner, but the results to date suggest this method will provide a clear differentiation between the primary and secondary types of hypothyroidism in children.

Atomic Bomb Casualty Commission

The Commission's long-range study of the delayed radiation effects of atomic detonations on the Hiroshima and Nagasaki populations is continuing under the Atomic Bomb Casualty Commission. This unique medical research investigation has functioned continuously since its inception in 1947, during the occupation of Japan. Before the Japanese peace treaty was signed, the Commission was attached to the U. S. Occupation Forces, Japan, and later to the U. S. Forces, Japan. Relationships with the Japanese Government now are established through the U. S. Embassy, Tokyo, Japan.

Identification of this project with the Japanese community is considered highly important in order to obtain the maximum scientific benefit from the work already accomplished. Whenever feasible, Japanese Nationals have been included on the staff of the ABCC. Several more years of clinical investigations and analytical determinations are planned. Continuation of the scientific program, with its major research components of genetics, medicine, and pathology, will provide basic information which should be beneficial to both nations.

Civil Defense

During the past 6 months, cobalt 60 radiation sources were loaned to civil defense organizations for use in radiological defense training in the States of Washington, California, and Texas. Radiation detection instruments also were loaned to civil defense groups in Texas and Delaware.

At the spring series of tests in Nevada, instruments were provided on loan to the Federal Civil Defense Administration, which participated in the tests as part of the Civil Effects Group. The FCDA program involved evaluation of radiological defense survey methods by means of actual field training exercises.

Radioactivity From Nevada Tests

The "fall-out" of radioactive particles from the clouds resulting from atomic detonations was described in detail in the Commission's Thirteenth Semiannual Report. Precautions taken by the Commission to safeguard the public against hazard from fall-out were discussed, as was the nation-wide system of detecting and measuring fall-out radioactivity.

During the spring 1953 series of test detonations, observed fall-out levels were somewhat higher than those recorded in past operations, though none was high enough to create a human health hazard.

Nevertheless, additional safeguards were taken in several instances to keep exposure of the public as low as possible.

Following two separate detonations, monitoring teams reported fall-out material on some portions of U. S. Highways 91 and 93, near Glendale, Nev. Vehicles traveling along these highways were monitored, and were washed at AEC expense if radioactivity in their interiors averaged 20 milliroentgens (0.02 roentgen) per hour or higher.

Just after the ninth detonation, a shifting of winds indicated that the atomic cloud would pass over St. George, Utah. While no hazard to health was anticipated, the residents of St. George were requested to remain indoors from about 9:30 to 11:30 a. m. during the time of actual fall-out. Residents at the Lincoln Mine, near the proving ground in Nevada, were requested to remain indoors for a few hours after the second detonation.

As explained in the Thirteenth Semiannual Report, it has been determined that a dose of 0.3 roentgens per week may be delivered to the whole body for an indefinite period without hazard. Though much larger rates of exposure are harmless if not continued too long, the Commission has adopted a policy of limiting exposures whenever possible to a total of not more than 3.9 roentgens over a period of 13 weeks, approximately the length of the 1953 test period. (A limit of 3 roentgens per 10 weeks was used for the 1952 test period, which was shorter.)

In evaluating the significance of the fall-out radioactivity measurements recorded during the 1953 series, the following factors should be kept in mind:

1. The figures represent extreme theoretical cases, calculated on the assumptions that (a) people remain in the locality 24 hours a day, (b) none of the radioactivity is lost through weathering by wind and rain, and (c) that there is no reduction of radiation due to intervening walls and floor. Film badge measurements in several communities and data obtained on the effects of weathering indicate that these calculated values are high by factors of about 2.

2. About 25 roentgens, delivered rapidly, are required to produce observable changes in the blood and germ cells, but these changes are transitory. A dose of about 100 roentgens, delivered in a very short time, is required to produce radiation symptoms. However, an accumulated dose of 100 roentgens would be undesirable for genetic reasons.

3. Because of the rapid decay of fall-out radioactivity, exposures during periods following the first 13 weeks would be far less than the dose for the first 13 weeks.

The highest radiation level noted in a populated place outside the proving ground was at a motor court near Bunkerville, Nev., with 15 nontransient residents, about 95 miles from the proving ground. At this location, fall-out was of sufficient intensity to deliver a theoretical maximum exposure of 9 roentgens in the first 13 weeks following fall-out.

As indicated above, this figure is about twice the actual radiation exposure which might have been received by a person in the locality. Because of the rapid decay of the radioactivity, the theoretical maximum exposure during an individual's entire lifetime in the locality would be only 13 roentgens.

Thirteen-week exposures for communities surrounding the proving ground ranged downward from a theoretical maximum of 5.2 roentgens. The 20 highest measurements for communities with populations of 50 or above are shown on the following table:

EXTERNAL GAMMA DOSES*

Location	Approximate population	13 weeks accumulated gamma dose (roentgens)
Bunkerville, Nev	200	5. 2
Hurricane, Utah	1, 500	5. 0
Rockville, Utah	300	4. 2
Santa Clara, Utah	300	3. 8
Springdale, Utah	200	3. 6
St. George, Utah	4, 500	3. 5
Lincoln Mine, Nev	200	3. 0
Veyo, Utah	100	2. 5
Kanab, Utah	1, 300	2. 2
Orderville, Utah	370	2. 2
Washington, Utah	435	1. 7
Virgin, Utah	150	1. 4
Kanarraville, Utah	265	1. 2
Mount Carmel Junction, Utah	125	1. 1
Enterprise, Utah	750	. 4
Cedar City, Utah	6, 200	. 4
Alamo, Nev	250	. 2
Mesquite, Nev	600	. 2
Duckwater, Nev	50	. 1
Lund, Nev	300	. 1

*These figures may be compared with the following typical exposures during X-ray examinations:

Routine chest X-rays	0.05 to 0.3 roentgen.
Routine gastro-intestional X-ray	1.0 roentgen per exposure.
X-ray of extremeties	0.25 to 1.0 roentgen.
Fluoroscopic examination	10 to 20 roentgens per minute.

Other communities surrounding the proving ground experienced either no fall-out or negligible amounts. Las Vegas, for example, received a 13-week dose amounting to about 0.005 roentgens.

During the test series, several persons in Nevada and surrounding States reported various symptoms, such as nausea, headache, rash, and the like, which they feared were caused by radiation. These cases were given careful investigation by representatives of both the AEC and the U. S. Public Health Service, with which close liaison was maintained throughout the series. None of the examinations substantiated the claims that radiation was involved. An example was the case of a child who suffered a rash which was found to be German measles. These and other persons who showed apprehension regarding test radioactivity were given factual explanations of the observed radiation levels to alleviate their concern.

Airborne Radioactivity

The highest concentrations of airborne radioactivity in communities surrounding the test site were as follows:

Locality	24-hour average concentration (microcuries per cubic meter)
St. George, Utah	1.29
Lincoln Mine, Nev	4.0×10^{-1}
Mesquite, Nev	1.7×10^{-1}
Groom Mine, Nev	3.4×10^{-2}
Pioche, Nev	2.0×10^{-2}
Nellis Air Force Base, Nev	1.7×10^{-2}
Ely, Nev	1.6×10^{-2}
Las Vegas, Nev	1.0×10^{-2}

As an operational guide, the test organization has attempted to hold airborne radioactivity to a level of 1 microcurie per cubic meter, averaged over 24 hours. Since the highest reading of 1.29 microcuries per cubic meter existed for only a single 24-hour period, it can be concluded that this was not a dangerous concentration level.

Radioactivity in Water

Measurements of radioactivity in water sources near the test site are shown in the table below:

Locality	Concentration microcuries per milliliter extrapolated to 3 days after detonation
Virgin River Irrigation Canal, Nev	8.7×10^{-5}
Irrigation Ditch, 56 miles north of Pioche, Nev	4.5×10^{-5}
Lower Pahranagat Lake, Nev	3.2×10^{-6}
Virgin River at Mesquite, Nev	2.6×10^{-6}
Bunkerville, Nev. (tap water)	1.2×10^{-6}
Crystal Springs, Nev. (tap water)	1.1×10^{-6}

The highest radioactivity noted in this table is about one-sixtieth of the level of 5×10^{-3} microcuries per cubic centimeter at 3 days after detonation used as an operational guide. Other water sources in the area, such as Lake Meade, contained negligible radioactivity.

Radiation Burns to Animals

After the first nuclear detonation in 1945, it was reported that cattle near Alamogordo, N. Mex., had small areas on their backs which had the appearance of burns. These were caused by the relatively heavy fall-out where the cattle were grazing near the site of the detonation. Similar burns were observed on cattle near the Nevada Proving Ground during the 1952 series and on horses following the 1953 test series. The injuries were limited to the immediate skin areas, and there is no evidence that the general health of the animals was affected by radiation. The cattle exposed in 1945 have suffered no loss in reproductive capacity, and their offspring have shown no variations from normal. Coincident with the 1953 test series, sheep and cattle grazing in Southern Nevada and Utah died. Malnutrition was a major factor in the deaths. Scientists from the AEC, aided by experts from the U. S. Public Health Service, the Department of Agriculture, Utah State Agriculture College, University of Nevada and the University of Tennessee, are making further investigations to determine whether the animals were affected by radiation.

Fall-out in Other Areas

As in previous test series, levels of fall-out radioactivity were highest in localities near the test site during the spring 1953 series. Some fall-out radioactivity, however, was noted in many parts of the Nation by the 121 monitoring stations operated by the U. S. Weather Bureau. After one detonation, unusually heavy fall-out was noted as far from Nevada as the Troy-Albany area in New York. Following a heavy rain in that area on the second day after the detonation, the concentration of radioactivity was from 100 to 200 curies per square mile. It is estimated that this level of radioactivity would result in about 0.1 roentgen exposure for the first 13 weeks following the fall-out. This exposure has no significance in relation to health.

Atomic Detonations and the Weather

The frequency of tornadoes and other abnormal weather conditions during the spring of 1953, coinciding in time with the Nevada test series, raised in the minds of many persons the question of whether the test detonations have had any effect upon the weather. This question has been given a great deal of attention by the technical staffs of the Commission, the U. S. Weather Bureau, and the U. S. Air Force. Observations were made continuously during and after the series, as in previous tests, to determine specific results, if any, on weather. No evidence to date indicates that these tests have altered weather patterns.

The energy of these detonations is insignificant compared with the forces of nature, and there is no reason to believe that the energy released could result in storms, rain, tornadoes or drought. From statistical weather studies, it is known that under normal conditions the atmosphere contains adequate concentrations of particulate matter to serve as nuclei for the formation of rain. Small additional amounts of dust particles contributed by atomic detonations in Nevada would not appreciably alter the concentrations in the atmosphere. Further, the characteristics of dust particles are not conducive to the formation of raindrops since they do not readily absorb and retain moisture.

On June 18, the U. S. Weather Bureau transmitted to the Commission the following statement on this subject:

> The rainy weather, the tornadoes, and other "unusual" weather which have aroused so much interest are in fact unusual only as regards the places where they have occurred. Excessive rains and tornadoes occur every year at one place or another in a country as large as the United States. The explanation of these conditions is revealed by a study of weather maps and the explanation this year appears to be the same as that in the years before the atomic bombs, namely, the interaction of widespread air masses with different characteristics of temperature and moisture content. These air masses, which cover hundreds of thousands of square miles and originate normally over the Arctic, the Pacific or the Gulf of Mexico, insofar as the United States is concerned, occur quite independently from atomic bomb explosions and are much too large to be affected by atomic bombs.
>
> Extensive studies of the occurrence of heavy rain, tornadoes, etc., in relation to the time of explosions of atomic bombs and the transport of the radioactive debris which is carried by the winds shows no relationship between the radioactive materials

and the occurrence of excessive rains and tornadoes. A study of the weather in years preceding the first atomic bomb shows similar periods of excessive rainfall and tornadoes that were no less destructive. Moreover, no such abnormal weather was observed following the atomic tests in the spring of 1952.

Finance

Since the financial section of the Thirteenth Semiannual Report was devoted to a condensed financial report for the fiscal year 1952, this report summarizes other significant finance developments during the entire fiscal year ended June 30, 1953.

Appropriations

During fiscal year 1953 AEC received appropriations for operating expenses totaling $797.1 million, appropriations for plant and equipment totaling $3,270.5 million, and an appropriation of $57 million for liquidation of contract authority. The funds appropriated for the last five fiscal years were as follows:

	Millions
1949	$621. 9
1950	702. 9
1951	2, 032. 1
1952	1, 605. 9
1953	[1] 4, 124. 6

[1] Excludes transfer of $11.8 million from Federal Bureau of Investigation.

Auditing

One of the most significant finance developments during the past fiscal year was in the field of auditing.

Beginning in October 1948, AEC audit policy emphasized the review of the financial records and reports of AEC and its major contractors by methods similar to those that public accounting firms use in making commercial financial examinations, and at the same time provided the standard Government-type verification of funds expended by AEC and its cost-type contractors. In December 1952 AEC revised its audit policy to make auditing a more effective tool in administering its operations by applying generally recognized industrial internal audit concepts to the atomic energy enterprise.

This revised audit policy, in addition to providing for an examination of financial transactions, controls and reports, provides for a review of the manner in which operations having financial implications are carried out from the viewpoint of compliance with, and suitability of, established policy and practice. The policy calls for major contractors to conduct internally a like audit of their own operations, which is reviewed and utilized in the AEC audit.

This broadened scope of audit is in line with the recent publication issued by the Comptroller General of the United States to all Federal agencies which stresses the need for a strong internal audit program as a part of the internal controls essential to good management.

Product Cost Accounting System

The product cost accounting system has now been in operation for a full year and AEC is getting unit-cost information on each significant production process. Comparisons of the various cost elements in relation to production from month to month are most useful in analyzing efficiency and measuring progress.

AEC and its contractors require cost data principally for cost control, program planning, and determining future courses of action. Specifically, the production cost system provides relative costs of such competitive products as enriched uranium and plutonium; an indication of the relative efficiencies of plants and contractors manufacturing the same products; and information for establishing production goals.

The present interest in industrial uses of atomic energy is focusing on cost as one of the most important factors to be considered. The Commission has made some cost information available to the groups of companies participating in studies to determine the economic feasibility of various nuclear reactor designs being considered for power production.

Financial Reporting

During the last 6 months AEC again reviewed the financial reporting system to test the usefulness of the reports being issued, to eliminate any unnecessary duplication of data, and to find out whether additional information was needed for operating. This survey has resulted in some changes in the financial reports.

The monthly highlight financial report described in the Twelfth Semiannual Report has been replaced by a report on cost-budget trends. This report, first published in March 1953, is a statistical analysis showing graphically how monthly costs for each program differ from budget projections in the financial plans. The report highlights the percentage of underrun or overrun for each budget program and major construction project. Each month a particular program is selected for more detailed analysis.

As a part of the effort to tailor financial reports more closely to the needs of the operating people, the Controller now issues a separate cost-budget report to the director of each AEC program division. These reports summarize program costs by operations office and make a detailed cost-budget comparison for the specific operations that the particular division administers. These revised reports and the unit cost reports showing production trends and analyses result from AEC's continuing efforts to provide better financial information for managing its operations.

AEC Controller's Manual

Publication of the AEC Controller's Manual started in January with Part I, Accounting, and Part III, Budgeting. During the following 6 months it was expanded to include Part II, Auditing, and Part IV, Insurance. This manual incorporates the policies and standards that AEC and its cost-type contractors follow in accounting, auditing, budgeting, contract financing, financial reporting, insurance, and other financial operations.

Insurance Costs

The remarkable safety record of the atomic energy enterprise has lowered the cost of the premiums that AEC cost-type contractors pay for workmen's compensation and general liability insurance. AEC realizes this benefit from its safety measures by arranging for insurance plans on an actual-cost basis. That is, instead of paying predetermined premiums, AEC negotiates retrospective rating plans with the insurance companies wherever possible and practicable.

The trend in AEC insurance costs is definitely downward. AEC continually analyzes its insurance costs and watches trends in such costs so as to have significant experience figures to use in negotiating insurance rates. The recent analyses indicate that the insurance costs on the contracts that are now active are running substantially below such costs for the contracts that have been closed.

The following summary of the costs of workmen's compensation insurance directly reimbursed to contractors of the Manhattan Engineer District and AEC from the beginning of contract operations to December 31, 1952, illustrates how low the rates are in relation to payroll:

Type of contract	Total cost	Payroll	Rate per $100 payroll
1. Construction	$4, 791, 170	$492, 437, 366	$0. 97
2. Operating	3, 124, 055	629, 144, 100	. 50
3. Town operations	536, 471	137, 919, 892	. 40
4. Construction-operating	1, 722, 238	621, 607, 800	. 30
5. Architect-engineering	6, 871	6, 509, 705	. 11

Information on Atomic Energy

The expanded AEC program and greater private interest in nuclear research and atomic power developments have led to a continuing increase in demands for technical information services. The AEC continued to meet these demands during the last 6 months by organizing closer cooperation among its contractors and other organizations, by improved operational procedures and by utilization of modern equipment and methods.

The Reactor Handbook

One principal technical information project concluded during the past 6 months was a classified comprehensive handbook on reactor technology. The handbook was written and edited by experienced reactor scientists in a number of AEC contractor organizations. Consisting of 4 volumes which total about 3,000 pages, *The Reactor Handbook* is the most complete reference work existing in this field.

The primary purpose of the reactor handbook is to provide atomic energy project scientists and engineers with a compilation of existing data which they require in further developmental work. The handbook is expected to help speed and improve future work by providing a single authoritative source of data, thus making it unnecessary for each individual researcher to sift the best data from the thousands of primary sources, such as reports, memoranda, conference notes, and the like.

Although the handbook as a whole is classified secret and distributed only to authorized recipients, it carries nonclassified data which will be extracted and published for the benefit of research workers outside Commission laboratories, serving as a basis for project scientists to prepare more literature for publication. This compilation also is expected to provide a better basis for the selection of data to be declassified than has heretofore existed.

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The Weapons Information Program

A significant development in technical information services has been the work done to improve the availability of atomic weapons data to the laboratories and agencies requiring such information. Until recent years, so few sites were involved in weapons work that very little external distribution of information was required. The expansion of the atomic weapons program, the organization of task forces for weapon tests, and the inclusion of military and civil effects studies in such programs have brought more individual technical workers into one phase or another of the weapons program. The quantity and significance of data derived from these programs have increased appreciably, so that to be useful, such information must be organized, catalogued, and distributed, all under rigid control to ensure that no information bearing on atomic weapons reaches any office unless the office has need for it and is properly cleared to receive it.

The relationship between the AEC and the Department of Defense is very close in the weapons information program, since the organization of weapons information must suit the purposes of both agencies. Accordingly, many information programs pertaining to weapon data have been conducted on a cooperative basis. A noteworthy result of this cooperation has been the preparation of the reports of the various atomic weapons test operations conducted at the Pacific and the Nevada Proving Grounds in the form of a standardized report series. This has produced improved reports, as well as permitting prompt and effective cataloging, precise distribution control, and better reference service.

Information to Industry

Ways to expedite the flow of unclassified technological information from the atomic energy program to American industry are resulting from continuing efforts to establish special information-for-industry services in AEC facilities throughout the country. Guidance in the development of this information program is coming from the Advisory Committee on Industrial Information (see Appendix 2) comprised of 16 representatives of technical societies and the industrial press, and internally from the Industrial Information Committee (see Appendix 2) representing the Commission and its major contractors.

The Advisory Committee has made several visits to AEC installations for the purpose of surveying and evaluating specific fields of AEC-developed technology from the viewpoint of industry. Full committee visits have been made to the Argonne and Brookhaven

National Laboratories, and individual members have visited Idaho, Hanford, Berkeley and Oak Ridge facilities. Reports recommending the declassification of specific subject matter have been submitted to the AEC, and these are now being reviewed for possible declassification. Meanwhile, the report recommendations are serving to guide information specialists and technical personnel at these sites in the preparation and publication of unclassified engineering articles and technical papers describing work that is of potential interest to industry outside the atomic energy program.

At the same time, special tours of unclassified areas are being arranged by various AEC installations to introduce more editors of technical and trade magazines to the unclassified industrial-type operations in these facilities and to bring them in contact with technical personnel as potential sources of publishable material. A symposium on zirconium metallurgy held at Los Angeles under the sponsorship of the American Society for Metals is an example of AEC cooperation with the technical societies in presenting a substantial quantity of material in a technological field to which the atomic energy program has contributed.

Recently, the Commission called on the Advisory Committee on Industrial Information for assistance in arranging for the unclassified distribution of the reports of the four industrial teams which studied power reactor feasibility (see p. 23). Two members of the Advisory Committee selected material likely to be most helpful to American industry and prepared condensed drafts of classified versions, from which the Commission chose the declassifiable material which was finally published.

Microcard Program

The Thirteenth Semiannual Report of the Commission described the adoption of the program in which AEC reports are reproduced in microcopy form on 3- x 5-inch cards. In the first year of the program, completed April 30, 1953, multiple copies of 10,200 reports were reproduced on a total of 425,000 cards. The cost of producing a microcard copy is substantially less than that of other available copy methods. Savings have ranged from 5 cents to $7.87 per report copy.

Microcards are sent only to the installations that request them. At present 38 installations affiliated with the AEC and other agencies, and 41 AEC depository libraries regularly receive and use the microcards.

Up to 35 pages of classified material or up to 47 pages of nonclassified material can be printed photographically on the face of one 3- x 5-inch card. The net saving in storage space is about 90 percent.

Technical Publications

In the National Nuclear Energy Series program one volume was published and several more were processed toward publication in the past 6 months. The published volume was parts 3 and 4 of Division VI, Volume 1, "The Pharmacology and Toxicology of Uranium Compounds." This publication is actually a continuation of the volume from parts 1 and 2, published in 1949. The earlier publication presented the results of the short term studies carried out at the University of Rochester. The later parts present the results of the long term studies on the subject. The entire volume is edited by Drs. Carl Voegtlin and Harold C. Hodge. This and all other volumes in the National Nuclear Energy Series are published by the McGraw-Hill Book Co., New York.

Among other volumes to be published in the NNES the following are nearing completion: Division IV, Volume 14A, "The Transuranium Elements Survey" edited by Seaborg and Katz; Division IV, Volume 22B, "Biological Effects of External X and Gamma Radiation" edited by Zirkle; Division IV, Volume 8, "Optical Instrumentation" edited by Monk and McCorkle, and Division VI, Volume 2, "Biological Effects of External Radiation" edited by Charles.

Public Information

One of the test detonations at the Nevada Proving Ground was witnessed from a distance of 7 miles on March 17 by a group of approximately 450 civil defense observers and 300 newsmen. This observer exercise, similar to but somewhat larger than that of April 22, 1952, was primarily for the benefit of the Federal Civil Defense Administration, at whose request the AEC made the unclassified viewing possible. Although the detonation was primarily for the purpose of testing an atomic device under precisely controlled conditions in the Commission's outdoor laboratory in Nevada, it was utilized also to illustrate the effects of a relatively small atomic bomb (energy release equal to that of approximately 15,000 tons of TNT) upon two residential-type structures, upon vehicles and a variety of types of bomb shelters. In spite of the comparatively small size of the detonation, it made possible a demonstration on which was based dissemination to the public of information regarded by the FDCA as useful in civil defense.

EDUCATIONAL SERVICES

A traveling exhibit on atomic energy sponsored jointly by the National University Extension Association and the American Museum of Atomic Energy at Oak Ridge has completed its second year of operation. It has been viewed by over 600,000 persons, in 56 separate localities in 20 States. Following are the States where it was shown during the 1952-53 season, together with the sponsoring institutions: Georgia, Georgia Institute of Technology; Illinois, Southern Illinois University; Louisiana, University of Louisiana; Maine, University of Maine; Nebraska, University of Nebraska; New Hampshire, University of New Hampshire; New York, Syracuse University and Buffalo University; Texas, University of Texas and Rice Institute.

Present requests assure scheduling through at least another year and probably longer.

Radioisotope Laboratory Manual

Following an in-service training course on the use of radioisotopes in the high school science classroom, offered by the New York City Board of Education in cooperation with the Atomic Energy Commission, a group of New York City teachers who took the course prepared a manual covering 20 laboratory experiments using radioisotopes. This manual, based on actual experiments performed during a laboratory workshop, is presently being readied for publication and sale by the Government Printing Office.

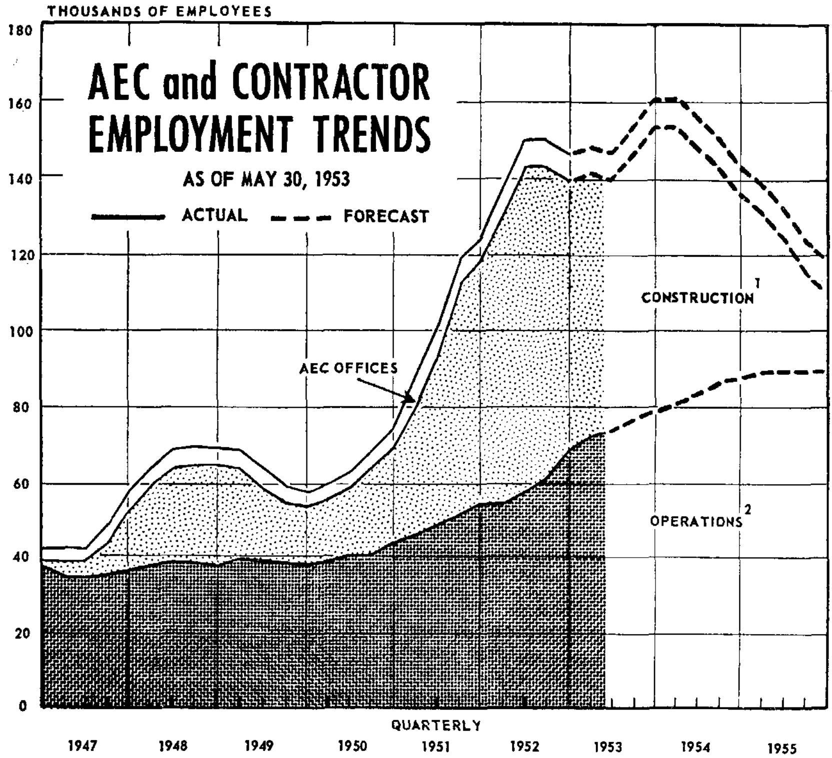
Declassification of Information

As a continuation of the policy of cooperation with respect to release of technical information shared by the United Kingdom, Canada, and the United States as a result of their combined wartime efforts, the Sixth International Declassification Conference was held on April 8 to 10, 1953, at Chalk River, Canada. This conference recommended changes in certain topics of the "Declassification Guide" in the light of developments since the previous conference in September 1951. The proposed revisions would permit the release of additional information concerning power reactors and associated technology. Agreement among the three nations on the categories of technical information to be released or declassified has resulted in uniform standards of secrecy for the fund of knowledge developed by the three nations in their atomic energy projects.

In keeping with its policy of declassifying as much information as can safely be released without adversely affecting the common defense and security, the Commission authorized the declassification of certain data concerning the design and operation of the Materials Testing Reactor (see p. 20).

Organization and Personnel

The total number of workers in the atomic energy program was about 146,300 on December 31, 1952, and remained at about that level on May 31, 1953. The following graph reflects total AEC and contractor (by operations and construction) employment from January 1947 to May 31, 1953, with forecasts of manpower requirements from June 1953 through 1955.[4]



[1]INCLUDES ARCHITECT-ENGINEERING. [2]INCLUDES PRODUCTION, RESEARCH AND DEVELOPMENT, AND SERVICES.

[4] The graph does not include personnel employed by concerns which will support the atomic energy program, e. g., the private utility firms which will supply electric power for the AEC plants in Portsmouth, Ohio, and Paducah, Ky.

As currently forecast, operations contractor employment is expected to continue to increase from 67,000 in December 1952, to 74,000 by June 1953, with a leveling off at 89,000 in June 1955. The permanent staffing of new facilities at Savannah River, Portsmouth, Lockland, and expanded activities at Oak Ridge, Hanford, Berkeley, Dayton, and Sandia account for most of the increase. Construction employment, including architect-engineer contractor employees, totaled 72,600 in December 1952. Although it is expected to decline to about 65,700 in June 1953, construction employment will increase to approximately 74,100 toward the end of 1953. Construction forces at Savannah River will decline slowly until the end of 1953 and sharply thereafter, while a sharp increase will occur at Portsmouth until peak employment is reached in December 1954. Peak construction employment at Hanford, Paducah, and Oak Ridge is expected in late 1953 or early 1954. Current AEC Federal employment remains at about 6,700.

Reduction of Extended Workweeks

The 54-hour workweek for construction at the Savannah River project, authorized by the Commission in March 1952, was reduced in February 1953, to alternate workweeks of 45 and 54 hours. The 50-hour extended workweek for construction at the Paducah, Ky., project, authorized by the Commission in March 1952, was reduced to 45 hours in March 1953. In both cases the reduction was made possible by the ability of the construction contractors to obtain sufficient qualified craftsmen to handle the construction materials and equipment delivered to the sites.

Labor Management Relations

The record for continuity of work at the AEC's operating installations continued to be outstanding. During the first 4 months of this year, 99.93 percent of scheduled time actually was worked. On construction projects, 98.30 percent of scheduled time actually was worked. Notably, in this connection a great improvement has been shown in the record of continuity of construction work at the Paducah, Ky., project. No major work stoppage occurred at Paducah during the period September 1952 through May 1953. The total construction time lost through work stoppages at the project for the 9-month period represents less than one-half of 1 percent of scheduled time. There was a brief stoppage at Paducah in June, which was settled by the international unions involved.

The dispute at the Dunkirk, N. Y., plant of the American Locomotive Co., an important supplier to the AEC program, was settled by agreement between the parties, shortly before the 80-day injunction imposed under the Labor Management Relations Act, 1947, would have expired. This dispute had resulted in a work stoppage at the Dunkirk plant lasting from August 29 until December 12, 1952. The shut-down seriously affected supply of material and equipment for various AEC installations, particularly process gas pipe for Paducah.

Labor Relations Panel

On March 6, 1953, the President accepted the resignations of the Chairman and members of the Atomic Energy Labor Relations Panel appointed by President Truman in 1949. Prior to that time, the panel issued written recommendations in a dispute between the International Association of Machinists (AFL) and the Bendix Aviation Corp., an AEC contractor in Kansas City, Mo. The panel's recommendations formed the basis for agreement between the parties. The President, on March 24, 1953, announced his intention to establish a new Atomic Energy Labor-Management Relations Panel within the Federal Mediation and Conciliation Service.

The President announced that the new panel will exercise substantially the same jurisdiction as was exercised by the previous panel.

Earnings of Atomic Energy Workers

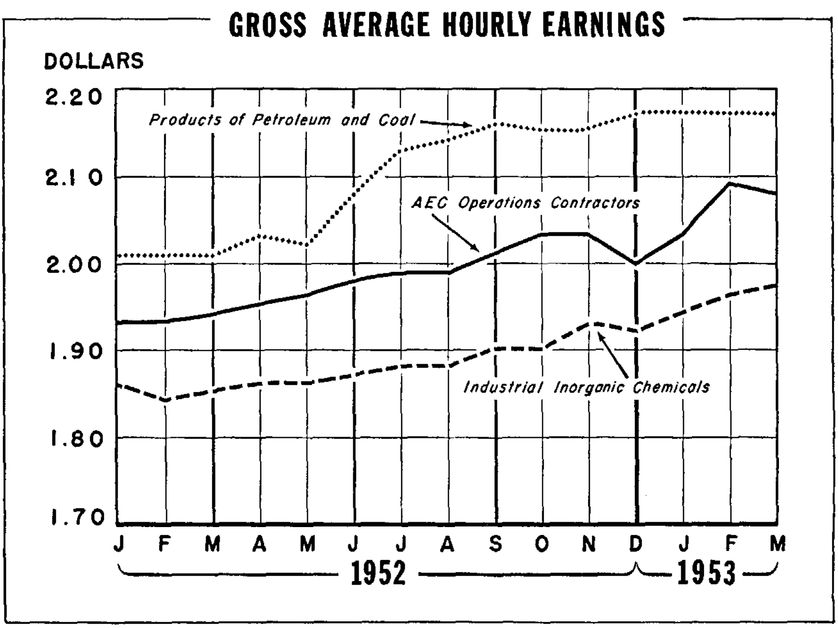
The table and graph on page 66 compare gross average hourly earnings of production workers of major contractors in the atomic energy program with those of employees in the two industries whose manufacturing operations are most nearly comparable—inorganic chemicals and petroleum and coal products. Gross average hourly earnings of atomic energy workers during March (the last month reported) were 5.3 percent above industrial inorganic chemicals and 4.4 percent below petroleum and coal products.

During the 15 months reported, earnings of atomic energy workers increased 7.7 percent, while earnings of workers in the inorganic chemicals and petroleum and coal-products industries increased 5.9 and 8.0 percent, respectively.

During the same period the average number of hours worked per week by atomic energy employees was 41.8; for petroleum and coal products, 40.6; and industrial inorganic chemicals, 41.1. Weekly hours for atomic energy workers, which averaged 41.6 during the first 9 months of 1952, increased to an average of 42.1 from October 1952 through March 1953.

GROSS AVERAGE HOURLY EARNINGS OF PRODUCTION WORKERS [1] OF AEC OPERATIONS CONTRACTORS COMPARED WITH THOSE OF EMPLOYEES OF SELECTED INDUSTRIES

1952	AEC operations contractors	Products of petroleum and coal	Industrial inorganic chemicals
January	1.93	2.01	1.86
February	1.93	2.01	1.84
March	1.94	2.01	1.85
April	1.95	2.03	1.86
May	1.96	2.02	1.86
June	1.98	2.08	1.87
July	1.99	2.13	1.88
August	1.99	2.14	1.88
September	2.01	2.16	1.90
October	2.03	2.15	1.90
November	2.03	2.15	1.93
December	2.00	2.17	1.92
1953			
January	2.02	2.17	1.94
February	2.09	2.17	1.96
March	2.08	2.17	1.96



[1] As defined by the Bureau of Labor Statistics, "production workers" include working foremen and all nonsupervisory workers engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping, maintenance, repair, janitorial, watchman services, product development, auxiliary production for plant's own use (e. g., power plant), record-keeping, and other services closely associated with the above production operations. Personnel of AEC construction contractors are not included in this tabulation.

Administrative Issuance Review

A comprehensive study of the administrative issuance system now used throughout the AEC is under way. Results of the study so far indicate that the present system does not satisfactorily meet the demands imposed by the increased size and complexity of Commission activities. An analysis was made of administrative issuance systems in use by 15 other Government agencies. A plan for a new system, combining the best features of each, is being considered for possible adaptation to AEC needs. Under such a system, all policies, standards, and prescribed procedures having mandatory application in the AEC would be collected in a single, easily revisable manual. Pertinent administrative information material also would be incorporated into the same manual in order to provide one complete, well-integrated and easily used reference source.

Junior Management Development Program

As an important means of recruiting and developing promising young persons for eventual placement in positions of responsibility, the AEC established a Junior Management Development Program, which began in June with 10 participants. The program involves careful selection of candidates, broad orientation to the major missions and programs of the AEC, rotational work assignments among the program and staff divisions, and placement in certain of the program divisions upon completion of the training assignments.

Safety and Fire Protection

The favorable downward trend in the frequency of accidents in atomic energy operations continued during the first quarter of 1953, with principal reduction in construction and motor vehicle accidents. The injury frequency rate in construction activities for the first quarter of 1953 was 1.96 injuries per million man-hours, 28 percent lower than the rate of 2.71 for the year 1952. Motor vehicle accidents involving Government-owned vehicles, which rose to a peak of 2.2 per 100,000 miles of operation at one point in 1952, were reduced to 1.31 during the first quarter of 1953, a reduction of 51 percent.

For the first 3 months of 1953, injury frequency rates per million man-hours for operating contractors and AEC Government offices were 2.20 and 1.15, respectively, which compares favorably with 2.29 and 1.96 for the year 1952. The injury frequency rate for all AEC activities declined from 2.51 for the year 1952 to 2.03 for the first quarter of 1953, a reduction of 19 percent. Four fatal accidents occurred in AEC activities during the first quarter of 1953, all of them on construction jobs. This represents a rate of 2.8 fatal accidents per 100,000 employees, as compared with 27 per 100,000 employees for all industries reported by the National Safety Council for 1951, the latest figures available.

Two of the persons who lost their lives in 1953 died in one fire in the first quarter of the year. The 1953 fire experience represents a projected fire loss of $0.0008 per $100 of property evaluation. This is below the national average, which in well-protected industrial properties is about $0.04 per $100.

Personnel Security Clearance Procedures

The Atomic Energy Act contemplates security clearance of all employees of the Commission and of all persons who will be permitted by AEC contractors or licensees to have access to restricted data.[5]

Security clearance is granted to an individual by the AEC after review of reports of investigations by the FBI or the Civil Service Commission and upon the determination that the common defense and security will not be endangered by allowing the individual to have access to restricted data. The Act requires that the investigation cover the character, associations and loyalty of the individual.

The Commission has recognized that the handling of clearance cases is one of the most important and difficult of its responsibilities, and that it is essential that clearance procedures and practices be effective in safeguarding the security of the program and at the same time be fair and just to the individuals concerned.

Since April 1948, incumbents in the atomic energy program have had the privilege of formal hearing and appeal if their continued eligibility for security clearance is questioned. In 1950, this privilege was extended to all applicants for AEC security clearance. Under the procedures, an individual whose eligibility for clearance has been questioned is entitled to a full hearing before a local personnel security board.[6] This board considers the entire record and makes findings with respect to the allegations and a recommendation to the local Manager of Operations as to whether clearance should be granted to a new applicant or continued for an incumbent. The manager of

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[5] "Restricted Data" as defined in the Atomic Energy Act means "all data concerning the manufacture or utilization of atomic weapons, the production of fissionable material, or the use of fissionable material in the production of power, but shall not include any data which the Commission from time to time determines may be published without adversely affecting the common defense and security."

[6] The procedures have been published in full in the Federal Register of September 12, 1950, page 6241.

operations in turn makes a recommendation to the AEC General Manager, whose decision is final.

If an adverse recommendation is made by the manager of operations the individual has the right to have his case considered on the basis of the entire record by the AEC Personnel Security Review Board (see Appendix 2). The Review Board submits its recommendations to the General Manager of the AEC for his final decision.

As a matter of employment policy, the AEC emphasizes the importance of thorough screening of applicants before requesting security investigations. Personnel officers of the AEC and its contractors are encouraged to make the fullest possible use of the normal preemployment practices generally followed in recruitment of persons for similar positions and responsibilities. Checks are made with references and previous employers to ascertain the applicant's general suitability for employment, including such factors as reliability, integrity, personal habits, professional qualifications and ability.

In making these checks, matters concerning loyalty or associations of a subversive nature are not pursued. Investigation of such matters is the responsibility of the FBI under provisions of the Atomic Energy Act as amended. However, if information reflecting on an applicant's loyalty or associations is received in the normal course of a preemployment check and if the employer subsequently requests security clearance for the individual, he is encouraged to transmit such information to the AEC with the applicant's personnel security questionnaire for the use of the agency making the security investigation.

As a result of the preemployment check program, applicants who are reported to be unreliable and to have character defects which might later affect their eligibility for security clearance are rejected by prospective employers on grounds of unsuitability, so that the question of eligibility for security clearance does not arise.

Every applicant for security clearance fills out a personnel security questionnaire. He must certify that the information which he has listed on this questionnaire is correct and complete to the best of his knowledge and belief. He also must certify that he makes the statement with the understanding that it will be used by the Commission in carrying out its duty to protect the security of the Atomic Energy project, and with knowledge that any false statement or omission of material fact may be sufficient cause for rejection of his application or dismissal after employment, and, further, that any false statement may be punished as a felony.

Upon discovery that an applicant has made false statements in or has omitted material facts from his questionnaire, he is notified in writing by the manager of operations of the material facts which were omitted or falsified. The applicant is advised that unless an acceptable explanation of the falsifications or omissions is made within 15 days, his case will not be processed further and his employer will be notified that the request for security clearance is canceled.

If the applicant provides an acceptable explanation, the case is processed in accordance with normal security clearance procedures. A request for clearance is canceled under this procedure only when it is fair to assume that the falsifications or omissions are intentional, and when the information developed by the investigation reflects unfavorably on the applicant's character. These cases generally involve omission of arrest records or falsification of the reason for termination of previous employment. This procedure has reduced the number of cases in which determinations of eligibility for security clearance must be made.

After the results of the security investigations have been analyzed and summary statements have been written, it has been found advisable in the majority of instances in which information with substantially derogatory implications has been reported to interview the applicants for clearance informally prior to or instead of resorting to the formal hearing procedure. The informal interview is used in all cases when there is reason to believe that the derogatory implications of reported information may be offset by verifiable extenuating information which may eliminate doubt. The informal interview also is used when it is believed that information may be elicited which would warrant or permit further investigation by the FBI or the Civil Service Commission. It is not used in cases where the derogatory implications of the reported information are so serious that regardless of the results of the informal interview, the need for a formal hearing would still be indicated; nor is clearance ever denied on the basis of an informal interview. Thus, the time-consuming and expensive formal hearing and appeal procedures are applied only to those cases in which there is good reason to believe that the derogatory implications of the reported information cannot be resolved by means of the informal procedures.

During the period from January 1, 1947, through December 31, 1952, the AEC requested background investigations for approximately 397,000 individuals as a basis for determining eligibility for security clearance. Approximately 4,000 of the cases, the bulk of whom were applicants, involved information with derogatory implications sufficient to cause the individual's eligibility for clearance to be questioned. Slightly more than one-half of these cases were not processed to conclusion for one reason or another, such as a decision by the employer not to use the services of the individual concerned in a place involving access to restricted data, as had been originally contemplated, or the resignation or dismissal of the individual before a clearance determination could be made. In somewhat more than 25 percent of the 4,000 cases, security clearance was granted following informal interviews or formal hearings. Security clearance had been denied or revoked in about 450 cases, as of December 31, 1952. Some of these denials occurred before the AEC adopted the formal hearing and appeal procedures.

Formal hearings had been held in 287 cases as of December 31, 1952. In 33 of these, the request for clearance was withdrawn after the hearing was held but before the clearance determination was made. Clearance was granted or reaffirmed in 104 cases after hearing and was denied or revoked in 70. As of December 31, 1952, 80 cases were pending in various stages of the hearing and review process.

It is the Commission's conclusion that the hearing and appeal procedures have been helpful in a number of ways. While the hearings are both costly and time-consuming, they permit in most instances sifting and analysis of the reported information and the testimony of the subject and his witnesses which would not be otherwise possible. This is usually very helpful in determining the degree of security risk, if any, which would be involved in permitting the individuals concerned to have access to restricted data. At the same time, knowledge on the part of applicants and employees that these procedures are available to them has built confidence in the administration of the program, helped employee morale and aided personnel recruitment.

AEC Use of the Lie Detector

During 1945 the Manhattan Engineer District, which was then administering the atomic energy program, became greatly concerned over the possible diversion of final product at one of the production plants at Oak Ridge. Various physical security measures to prevent and detect diversion of material had been considered, including the use of Beta meters, fluoroscopes and physical examinations of employees. All these measures were ruled out as being unsatisfactory for the desired purpose because of inherent weaknesses or because they were objectionable from the viewpoint of employee morale. A decision was finally made to introduce the lie detector for examination of all employees in one of the plant areas, since it was felt that the use of the lie detector, plus the security clearance of all employees based upon an investigation, would provide a satisfactory guarantee of the security of the final product.

Early in 1946, the Manhattan Engineer District negotiated a contract with a lie detector operator for the examination of certain employees at Oak Ridge. This contract was assumed by the AEC when it took over the administration of the atomic energy project in January 1947.

As a result of a recent study of all available information including data on lie detector use at Oak Ridge and its use in other activities, the Commission concluded that there was considerable doubt as to the utility of lie detector techniques in the AEC security program. In weighing the advantages which might be expected to accrue to the AEC security program by the use of lie detector techniques on a Commission-wide basis, it was found that a lie detector program could be expected to result in only an indeterminate marginal increase in security beyond that which is currently afforded by established AEC security procedures. Against such increase in security, consideration was given not only to the very substantial dollar costs of a lie detector program but also the intangible costs which its use might create in terms of employee morale and personnel recruitment. After weighing all of these factors the conclusion was reached that the unfavorable factors involved in a lie detector program outweighed whatever increase in AEC security might be achieved by its use.

Accordingly, on March 18, 1953, the AEC directed the discontinuance of the lie detector program at Oak Ridge and limited its future use on a voluntary basis to specific cases of security interest when authorized by the general manager. The Commission also directed that the study of lie detector usage be continued for possible future consideration of its applicability to the AEC security program.

APPENDIX 1

ORGANIZATION AND PRINCIPAL STAFF OF U. S. ATOMIC ENERGY COMMISSION

Atomic Energy Commission	LEWIS L. STRAUSS, *Chairman*.[1]
	THOMAS E. MURRAY.
	H. D. SMYTH.
	EUGENE M. ZUCKERT.
	(Vacancy).
General Manager	M. W. BOYER.
Special Assistant to General Manager	EDWARD R. TRAPNELL.
Deputy General Manager	WALTER J. WILLIAMS.
Assistant General Manager for Administration	JAMES L. KELEHAN.
Controller	DON S. BURROWS.
General Counsel	WILLIAM MITCHELL.
Secretary to Commission	ROY B. SNAPP.
Director, Office of Classification	JAMES G. BECKERLEY.
Director, Office of Industrial Development	WILLIAM L. DAVIDSON.
Director, Office of Intelligence	WALTER F. COLBY.
Chief, Office of Operations Analysis	DAVID P. HERRON.
Chief, Office of Special Projects	JOHN A. HALL.
Director, Division of Biology and Medicine	Dr. JOHN C. BUGHER.
Director, Division of Engineering	LAWRENCE R. HAFSTAD, *Acting*.
Director, Division of Military Application	Brig. Gen. K. E. FIELDS.
Manager, Santa Fe (Albuquerque, N. Mex.) Operations Office	CARROLL L. TYLER.
Manager, Burlington (Iowa) Field Office	E. W. GILES.
Manager, Eniwetok Field Office (Albuquerque, N. Mex)	PAUL W. SPAIN.
Manager, Kansas City (Mo.) Field Office	JAMES C. STOWERS.
Manager, Las Vegas (Nev.) Field Office	SETH R. WOODRUFF, Jr.

[1] Gordon Dean was AEC Chairman during the period covered by this report. His term expired on June 30, 1953. His successor as a Commission member and as Chairman is Mr. Strauss, who took office on July 2, 1953. Mr. Strauss' term will run to June 30, 1958.

Director, Division of Military Application—Continued	
Manager, Santa Fe—Continued	
Manager, Los Alamos (N. Mex.) Field Office	Frank C. DiLuzio.
Manager, Pantex (Amarillo, Tex.) Field Office	Walter W. Stagg.
Manager, Rocky Flats (Colo.) Field Office	Gilbert C. Hoover.
Manager, Sandia (N. Mex.) Field Office	Daniel F. Worth, Jr.
Director, Division of Production	R. W. Cook.
Manager, Hanford (Wash.) Operations Office	David F. Shaw.
Manager, New York (N. Y.) Operations Office	Henry B. Fry.
Manager, Brookhaven (Long Island, N. Y.) Area	E. L. Van Horn.
Manager, Cleveland (Ohio) Area	Buford Sparks.
Manager, Fernald (Cincinnati, Ohio) Area	C. L. Karl.
Manager, St. Louis (Mo.) Area	J. Perry Morgan.
Manager, Oak Ridge (Tenn.) Operations Office	S. R. Sapirie.
Manager, Dayton (Miamisburg, Ohio) Area	John H. Roberson.
Manager, Paducah (Ky.) Area	Ernest A. Wende.
Manager, Portsmouth (Ohio) Area	Kenneth A. Dunbar.
Manager, Savannah River (Augusta, Ga.) Operations Office	Curtis A. Nelson.
Manager, Dana (Terre Haute, Ind.) Area	Charles W. Reilly.
Manager, Wilmington (Del.) Area	D. Ewing Irons.
Director, Division of Raw Materials	Jesse C. Johnson.
Manager, Grand Junction (Colo.) Operations Office	Sheldon P. Wimpfen.
Director, Division of Reactor Development	Lawrence R. Hafstad.
Manager, Chicago (Ill.) Operations Office	A. Tammaro.
Manager, Ames (Iowa) Area	W. W. Lord.
Manager, Lockland (Ohio) Area	E. M. Velten.
Manager, Pittsburgh (Pa.) Area	Lawton D. Geiger.

Director, Division of Reactor Development—Continued	
Manager, Idaho (Idaho Falls) Operations Office	L. E. JOHNSTON.
Manager, San Francisco (Calif.) Operations Office	JOHN FLAHERTY.
Manager, Schenectady (N. Y.) Operations	JON D. ANDERSON.
Director, Division of Research	THOMAS H. JOHNSON.
Director, Division of Construction and Supply	E. J. BLOCH.
Director, Division of Information Services	MORSE SALISBURY.
Director, Division of Organization and Personnel	OSCAR S. SMITH.
Director, Division of Security	JOHN A. WATERS. Jr.

APPENDIX 2

Membership of Committees

STATUTORY COMMITTEES

Joint Committee on Atomic Energy—Eighty-third Congress

This committee was established by the Atomic Energy Act of 1946 (sec. 15) 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.

Representative W. Sterling Cole (New York), *chairman.*
Senator Bourke B. Hickenlooper (Iowa).
Senator Eugene D. Millikin (Colorado).
Senator William F. Knowland (California).
Senator John W. Bricker (Ohio).
Senator Guy R. Cordon (Oregon).
Senator Richard B. Russell (Georgia).
Senator Edwin C. Johnson (Colorado).
Senator Clinton P. Anderson (New Mexico).
Senator John O. Pastore (Rhode Island).
Representative Carl Hinshaw (California).
Representative James E. Van Zandt (Pennsylvania).
Representative James T. Patterson (Connecticut).
Representative Thomas A. Jenkins (Ohio).
Representative Carl T. Durham (North Carolina).
Representative Chet Holifield (California).
Representative Melvin Price (Illinois).
Representative Paul J. Kilday (Texas).
Corbin Allardice, *executive director.*

Military Liaison Committee

Under sec. 2 (c) of the Atomic Energy Act of 1946, as amended, "there shall be a Military Liaison Committee consisting of a chairman, who shall be the head thereof, and of a representative or representatives of the Departments of the Army, Navy, and Air Force, detailed or assigned thereto, without additional compensation, in such number as the Secretary of Defense may determine. Representatives from each of the three Departments shall be designated by the respective Secretaries of the Army, Navy, and Air Force. The committee chairman shall be appointed by the President, by and with the advice and consent of the Senate, and shall receive compensation at a rate prescribed by law for the Chairman of the Munitions Board. The Commission shall advise and consult with the committee on all atomic energy matters which the committee deems to relate to military applications, including the development, manufacture, use and storage of bombs, the allocation of fissionable material for military research, and the control of information relating to the manufacture or utilization of atomic weapons. The Commission shall keep the committee fully informed of all such matters before it and the committee shall keep the Commission fully informed of all atomic energy activities of the Department of Defense. The committee shall have authority to make written recommendations to the Commission on matters relating to military applications from time to time as it may deem appropriate. If the committee at any time concludes that any action, proposed action, or failure to act of the Commission on such matters is adverse to the responsibilities of the Department of Defense, derived from the Constitution, laws, and treaties, the committee may refer such action, proposed action, or failure to act to the Secretary of Defense. If the Secretary concurs, he may refer the matter to the President, whose decisions shall be final."

Hon. Robert LeBaron, *chairman.*
Brig. Gen. Kenner F. Hertford, United States Army.
Brig. Gen. Harry McK. Roper, United States Army.
Rear Adm. George C. Wright, United States Navy.
Capt. James S. Russell, United States Navy.
Maj. Gen. James E. Briggs, United States Air Force.
Maj. Gen. Howard G. Bunker, United States Air Force.

General Advisory Committee

This committee was established by the Atomic Energy Act of 1946 (sec. 2 (b)). 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; the committee held its first meeting in January 1947, and to date has averaged six meetings a year.

Dr. I. I. Rabi, chairman; professor of physics, Columbia University, New York, N. Y.
Dr. Oliver E. Buckley, former chairman, Bell Telephone Laboratories, New York, N. Y.
Dr. J. B. Fisk, director of research, Bell Telephone Laboratories, Murray Hill, N. Y.
Dr. W. F. Libby, professor of chemistry, University of Chicago, Chicago, Ill.
Eger V. Murphree, president, Standard Oil Development Co., New York, N. Y.
Dr. John Von Neumann, professor, school of mathematics, Institute for Advanced Studies, Princeton, N. J.
Dr. J. C. Warner, president, Carnegie Institute of Technology, Pittsburgh, Pa.
Walter G. Whitman, chairman, Research and Development Board, Department of Defense, Washington, D. C.
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.

PATENT COMPENSATION BOARD

This board was established in April 1949 pursuant to section 11 of the Atomic Energy Act of 1946, which 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. To date the board has held 10 sessions; 12 cases have been filed, of which 7 have been finally determined by the board; 1 claim has been awarded and 1 claim has been withdrawn.

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 appointed in 1946 by the Manhattan District and reaffirmed by the AEC has been increased from four to six members to meet the expanding scope of the Atomic Energy Commission's technical activities. The committee reviews the major phases of the Atomic Energy Commission program and is the principal adviser to the Commission on classification and declassification matters, making recommendations for formulating and modifying the rules and guides for classifying scientific and technical information. The committee members are appointed for a term of 5 years on a rotating basis. The next new appointment will be made on July 1, 1953.

Dr. WARREN C. JOHNSON, chairman; associate dean of physical sciences, University of Chicago, Chicago, Ill.
Dr. R. H. CRIST, director of physical research, Carbide & Carbon Chemicals Co. Plant, Charleston, W. Va.
Dr. THOMAS B. DREW, head, department of chemical engineering, Columbia University, New York, N. Y.
Dr. JOHN P. HOWE, group leader, research engineering laboratory, North American Aviation, Inc., Downey, Calif.
Dr. J. M. B. KELLOGG, division leader, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.
Dr. J. R. RICHARDSON, associate 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. E. C. STAKMAN, chairman; chief, division of plant pathology and botany, University of Minnesota, Minneapolis, Minn.
Dr. EDWARD A. DOISY, director, department of physiology and biochemistry, St. Louis University School of Medicine, St. Louis, Mo.
Dr. GIOACCHINO FAILLA, head, department of radiology, Columbia University Medical School, New York, N. Y.

Dr. Curt Stern, professor of zoology, University of California, Berkeley, Calif.
Dr. Shields Warren, pathologist, New England Deaconess Hospital, Boston, Mass.

Advisory Committee on Chemistry

This committee was appointed in June 1949 to advise on policy concerning the AEC program of supporting basic unclassified chemistry research in universities, and the relationship of this program to the AEC's own chemistry research program. Most of the work of the committee is accomplished by individual consultation as specific problems arise.

Dr. Farrington Daniels, professor of chemistry, University of Wisconsin, Madison, Wis.
Dr. G. B. Kistiakowsky, professor of chemistry, Harvard University, Cambridge, Mass.
Dr. Joseph E. Mayer, professor of chemistry, University of Chicago, Chicago, Ill.
Dr. Don M. Yost, professor of chemistry, California Institute of Technology, Pasadena, Calif.

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

This committee was reconstituted and expanded in April 1952 to replace an ad hoc committee appointed in 1949 to advise the AEC on disseminating unclassified technological information to industry. The members are visiting AEC sites to identify information of use to industry which should be submitted for declassification and recommending arrangements for the widest possible publication and distribution of such declassifiable information.

Sidney D. Kirkpatrick, chairman; vice president and director of editorial development, McGraw-Hill Book Co., Inc., New York, N. Y.
H. E. Blank, Jr., editor, Modern Industry, Magazines of Industry, Inc., New York, N. Y.

Dr. Allan G. Gray, editor, Steel, Penton Publishing Co., Cleveland, Ohio.
Gene 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.
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.
Karl T. Schwartzwalder, The American Ceramic Society, Inc., Columbus, Ohio.
George F. Sullivan, managing editor, The Iron Age, Chilton Publications, Inc., New York, N. Y.
E. E. Thum, editor, Metal Progress, American Society for Metals, Cleveland, Ohio.
S. A. Tucker, publications manager, American Society of Mechanical Engineers, New York, N. Y.
F. J. Van Antwerpen, editor, Chemical Engineering Progress, American Institute of Chemical Engineers, New York, N. Y.
Dr. Alberto F. Thompson, secretary; chief, technical information service, division of information services, AEC, Washington, D. C.
N. H. Jacobson, assistant secretary; chief, industrial information branch, division of information services, AEC, Washington, D. C.

Industrial Information Committee

This committee, representing AEC operating divisions and offices of operations and the major contractors, was appointed in 1952 to guide the dissemination of AEC-developed information to industry. Meetings are held three times a year.

Dr. Alberto F. Thompson, chairman; chief, technical information service, division of information services, AEC, Washington, D. C.
H. C. Baldwin, director of information, Chicago Operations Office, AEC, Lemont, Ill.
Dr. Brewer F. Boardman, head, technical information branch, Idaho Operations Office, AEC, Idaho Falls, Idaho.
George L. Brown, manager of public relations, General Electric Co., Hanford Works, Richland, Wash.
Dr. F. L. Cuthbert, technical director, National Lead Co. of Ohio, Cincinnati, Ohio.
H. W. Davis, Jr., deputy director, technical and production division, Savannah River Operations Office, AEC, Augusta, Ga.
W. E. Dreeszen, administrative aide to director, Ames Laboratory, Ames, Iowa.
R. G. Elliott, director of information, Sante Fe Operations Office, AEC, Albuquerque, N. Mex.
Lester C. Furney, assistant to director, Argonne National Laboratory, Lemont, Ill.

J. F. HAGGERTY, biochemist, medical branch, division of biology and medicine, AEC, Washington, D. C.

WILLIAM H. HAMILTON, staff assistant to assistant manager, Westinghouse Atomic Power Division, Pittsburgh, Pa.

W. L. HARWELL, head, patents and declassification department, Carbide & Carbon Chemicals Co., div. of Union Carbide & Carbon Corp., Oak Ridge, Tenn.

EDWARD L. HILL, supervisor, technical services, General Electric Co., Lockland, Ohio.

JOHN F. HOGERTON, technical reports director, Vitro Corp. of America, New York, N. Y.

F. R. KELLER, assistant to general manager, atomic energy division, American Cyanamid Co., New York, N. Y.

DAVID P. KUNTZ, organization and methods examiner, division of raw materials, AEC, Washington, D. C.

FRANK R. LONG, supervisor, technical information group, atomic energy research department, North American Aviation, Inc., Downey, Calif.

Dr. GEORGE G. MANOV, office of industrial development, AEC, Washington, D. C.

Dr. DONALD F. MASTICK, technical assistant, division of military application, AEC, Washington, D. C.

Dr. A. R. MATHESON, head, technical operations division, Schenectady Operations Office, AEC, Schenectady, N. Y.

GORDON R. MOLESWORTH, assistant to manager for public education, Oak Ridge Operations Office, AEC, Oak Ridge, Tenn.

Dr. DANIEL J. PFLAUM, chief, materials and information branch, division of research, AEC, Washington, D. C.

Dr. FRANK K. PITTMAN, assistant director for operations, division of production, AEC, Washington, D. C.

DENNIS PULESTON, head, technical information division, Brookhaven National Laboratory, Upton, Long Island, N. Y.

Dr. H. W. RUSSELL, assistant director, Battelle Memorial Institute, Columbus, Ohio.

Dr. CHARLES SLESSER, director, division of technical information and declassification, AEC, New York Operations Office, New York, N. Y.

Dr. RALPH CARLISLE SMITH, assistant director for classification and security, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

Dr. JOHN R. STEHN, physicist, theoretical physics division, Knolls Atomic Power Laboratory, Schenectady, N. Y.

Dr. M. H. WAHL, atomic energy division, E. I. du Pont de Nemours & Co., Atlanta, Ga.

Dr. R. K. WAKERLING, chief, information division, Radiation Laboratory, University of California, Berkeley, Calif.

WILLIS H. WALDO, technical editor, Mound Laboratory, Miamisburg, Ohio.

H. J. WALLIS, superintendent, development staff services, Sandia Corp., Albuquerque, N. Mex.

J. W. YOUNG, technical information officer, division of reactor development, AEC, Washington, D. C.

N. H. JACOBSON, secretary; chief, industrial information branch, 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. ROBLEY D. EVANS, chairman; professor of physics, Massachusetts Institute of Technology, Cambridge, Mass.

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

Dr. RICHARD CHAMBERLAIN, University of Pennsylvania Medical School, Philadelphia, Pa.

Dr. JOHN E. CHRISTIAN, associate professor, department of pharmaceutical chemistry, Purdue University, Lafayette, Ind.

Dr. SAMUEL E. EATON, A. D. Little, Inc., Cambridge, Mass.

Dr. STERLING B. HENDRICKS, head chemist, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture, Beltsville, Md.

Dr. DONALD E. HULL, research chemist, process division, California Research Corp., Richmond, Calif.

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. HOWARD E. SKIPPER, associate director, Southern Research Institute, Birmingham, Ala.

Dr. JOHN E. WILLARD, professor of chemistry, University of Wisconsin, Madison, Wis.

Dr. PAUL C. AEBERSOLD, secretary; chief, isotopes division, AEC, Oak Ridge, Tenn.

Neutron Cross Sections Advisory Group

This group is appointed on a yearly basis to make a continuing review of the AEC program of neutron 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 1952 to July 1953.

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

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

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

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

Dr. ALEXANDER S. LANGSDORF, physics division, Argonne National Laboratory, Chicago, Ill.

Dr. CARL O. MUELHAUSE, department of physics, Brookhaven National Laboratory, Upton, Long Island, N. Y.

Dr. G. ROY RINGO, physics division, Argonne National Laboratory, Chicago, Ill.

Dr. ARTHUR H. SNELL, physics division, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Dr. THOMAS M. SNYDER, physics division, Knolls Atomic Power Laboratory, Schenectady, N. Y.

Dr. JOHN R. STEHN, physics division, Knolls Atomic Power Laboratory, Schenectady, N. Y.

Dr. RICHARD F. TASCHEK, department of physics, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

Dr. CARROLL W. ZABEL, department of physics, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.
Dr. GEORGE A. KOLSTAD, vice-chairman; physics branch, division of research, AEC, Washington, D. C.
Dr. IRA F. ZARTMAN, division of engineering, AEC, Washington, D. C.
Dr. HERBERT GOLDSTEIN, secretary; Nuclear Development Associates, Inc., White Plains, N. Y.

Patent Advisory Panel

This panel was appointed in January 1947 to make a general review and appraisal of the problems raised by the patent provisions of the Atomic Energy Act of 1946. 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.; chairman, Patent Survey Committee, U. S. Department of Commerce.
JOHN A. DIENNER; of Brown, Jackson, Boettcher & Dienner, Chicago, Ill.
HECTOR M. HOLMES; of Fish, Richardson & Neave, Boston, Mass.
CASPER W. OOMS; firm of Casper W. Ooms, Chicago, Ill.

Advisory Committee on Personnel Management

This committee of leading authorities from government, industry, and education was named in September 1948 to provide the Atomic Energy Commission with a continuous review of its personnel management practices and to evaluate the best personnel methods of government and industry in determining over-all AEC policies. The committee usually meets once a month.

ARTHUR S. FLEMMING, chairman; director, Office of Defense Mobilization, Washington, D. C.; president, Ohio Wesleyan University, Delaware, Ohio.
L. CLAYTON HILL, professor of industrial relations, University of Michigan, Ann Arbor, Mich.
ROBERT RAMSPECK, vice president, Eastern Airlines, Inc., Washington, D. C.
WALLACE SAYRE, professor of public administration, school of business and civic administration, City College of New York, N. Y.
PHILLIP YOUNG, chairman, U. S. Civil Service Commission, Washington, D. C.
(Vacancy)

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.
ARTHUR S. FLEMMING, director, Office of Defense Mobilization, Washington, D. C.; president, Ohio Wesleyan University, Delaware, Ohio.
WILLIAM E. LEAHY, president, Columbus University, Washington, D. C.

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. The committee has met 12 times since its formation.

Chairmanship (*Vacancy*).

FRANCIS CAMERON, vice president, St. Joseph Lead Co., New York, N. Y.

EVERETTE L. DEGOLYER, petroleum geologist; DeGolyer & McNaughton, Dallas, Tex.

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

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

IRA B. JORALEMON, geologist, San Francisco, Calif.

FRANK W. MCQUISTON, Jr., metallurgical engineer, Newmont Mining Corp., New York, N. Y.

ERNEST H. ROSE, chemical engineer, Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.

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

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

CLYDE E. WILLIAMS, director, Battelle Memorial Institute, Columbus, Ohio.

Stack Gas Problem Working Group

The appointment of this group was authorized in May 1948 to advise the Commission in connection with problems in the control of gaseous effluents from AEC installations. Although the group has held five formal meetings, it has more recently rendered assistance in this field through specific research and development projects directed by individual members and by individual consulting advice.

Dr. ABEL WOLMAN, chairman; head, department of sanitary engineering, Johns Hopkins University, Baltimore, Md.

Dr. PHILIP DRINKER, professor of industrial hygiene, Harvard University School of Public Health, Boston, Mass.

Dr. LYLE GILBERTSON, director, research and engineering department, Air Reduction Co., Murray Hill, N. J.

Dr. H. FRASER JOHNSTONE, professor of chemical engineering, University of Illinois, Urbana, Ill.

Dr. MOYER D. THOMAS, department of agricultural research, American Smelting & Refining Co., Salt Lake City, Utah.

Dr. WILLIAM P. YANT, director of research, Mine Safety Appliances Co., Pittsburgh, Pa.

Technical Information Panel

This panel, representing the major AEC research contractors, was appointed in June 1948 to advise the Commission on all aspects of its technical information services. Meetings are held three times a year to work out better methods of disseminating technical information.

Dr. ALBERTO F. THOMPSON, chairman; chief, technical information service, division of information services, AEC, Washington, D. C.

Dr. HENRY A. BLAIR, director, atomic energy project, University of Rochester, Rochester, N. Y.

Dr. BREWER F. BOARDMAN, head, technical information branch, Idaho Operations Office, AEC, Idaho Falls, Idaho.

Dr. F. L. CUTHBERT, technical director, National Lead Co. of Ohio, Cincinnati, Ohio.

W. E. DREESZEN, administrative aide to director, Ames Laboratory, Ames, Iowa.

WILLIAM H. HAMILTON, staff assistant to assistant manager, Westinghouse Atomic Power Division, Pittsburgh, Pa.

SYLVAN HARRIS, manager, documents department, Sandia Corp., Albuquerque, N. Mex.

W. L. HARWELL, head, patents and declassification department, Carbide & Carbon Chemicals Co., div. of Union Carbide & Carbon Corp., Oak Ridge, Tenn.

EDWARD L. HILL, supervisor, technical services, General Electric Co., Lockland, Ohio.

JOHN F. HOGERTON, technical reports director, Vitro Corp. of America, New York, N. Y.

FRANK R. LONG, supervisor, technical information group, atomic energy research department, North American Aviation, Inc., Downey, Calif.

GLENN MAYNARD, head, technical information center, California Research and Development Co., Livermore, Calif.

Dr. JAMES A. MERRILL, director, laboratory division, Goodyear Atomic Corp., Akron, Ohio.

Dr. E. J. MURPHY, assistant to research director, Carbide & Carbon Chemicals Co., div. of Union Carbide & Carbon Corp. (ORNL), Oak Ridge, Tenn.

Dr. G. M. MURPHY, professor of chemistry, New York University, New York, N. Y.

Dr. DANIEL J. PFLAUM, chief, materials and information branch, division of research, AEC, Washington, D. C.

DENNIS PULESTON, head, technical information division, Brookhaven National Laboratory, Upton, Long Island, N. Y.

Dr. RICHARD F. RILEY, chief, radiation chemistry section, atomic energy project, University of California, Los Angeles, Calif.

D. P. RUDOLPH, director, technical services division, Chicago Operations Office, AEC, Chicago, Ill.

Dr. H. W. RUSSELL, assistant director, Battelle Memorial Institute, Columbus, Ohio.

Dr. CHARLES SLESSER, director, division of technical information and declassification, AEC, New York Operations Office, New York, N. Y.

Dr. RALPH CARLISLE SMITH, assistant director for classification and security, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

Dr. JOHN R. STEHN, physicist, theoretical physics division, Knolls Atomic Power Laboratory, Schenectady, N. Y.

C. G. STEVENSON, head, technical information, technical section, engineering department, General Electric Co., Richland, Wash.

Dr. R. K. WAKERLING, chief, information division, Radiation Laboratory, University of California, Berkeley, Calif.

WILLIS H. WALDO, technical editor, Mound Laboratory, Miamisburg, Ohio.

Dr. JOHN C. WOODHOUSE, director, raw materials section, atomic energy division, E. I. du Pont de Nemours & Co., Wilmington, Del.

Dr. H. D. YOUNG, director, information division, Argonne National Laboratory, Chicago, Ill.

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. Voight

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
Associate Director, University Relationships....................Dr. Joseph C. Boyce
Assistant Director, Technical Services....................John T. Bobbitt

Bettis Plant (Westinghouse Electric Corp., Atomic Power Division, contractor), Pittsburgh, Pa.

Manager, Westinghouse Atomic Power Division....................Charles H. Weaver
Assistant Manager....................John W. Simpson
Assistant Manager....................Edmund T. Morris
Director of Development....................Dr. William E. Shoupp
Contract Manager....................W. Dee Shepherd

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 Directors — P. STUART MACAULAY
President, AUI — LLOYD V. BERKNER
Vice President, AUI and Laboratory Director — Dr. LELAND J. HAWORTH
Deputy Laboratory Director — Dr. GERALD F. TAPE
Assistant Director, University Liaison — Dr. ROBERT A. PATTERSON

Knolls Atomic Power Laboratory (General Electric Co., contractor), Schenectady, N. Y.

General Manager, Operating Department — K. R. VAN TASSEL
Manager, Technical Department — Dr. K. H. KINGDON

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 — Dr. JOSEPH J. BURDAGE

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 & A. and M. College
Mississippi State College
North Carolina State College
Rice Institute
Tulane University of Louisiana
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. GEORGE H. BOYD
Vice Chairman of Council — Dr. W. W. GRIGORIEFF

President of Institute — Dr. Paul M. Gross
Vice President of Institute — Dr. J. W. Beams
Scientific and Educational Consultant — Dr. George B. Pegram
Executive Director of Institute — Dr. William G. Pollard

Oak Ridge National Laboratory (Carbide & Carbon Chemicals Co., div. of Union Carbide & Carbon Corp., contractor), Oak Ridge, Tenn.

Director — Dr. C. E. Larson
Research Director — Dr. A. M. Weinberg
Deputy Research Director — Dr. J. A. Swartout
Assistant Research Director — Dr. E. H. Taylor
Assistant Research Director — Dr. E. D. Shipley
Assistant Research Director — Dr. C. E. Winters

Radiation Laboratory (University of California, contractor), Berkeley, Calif.

Director — Dr. Ernest O. Lawrence
Associate Director — Dr. Donald Cooksey
Business Manager and Managing Engineer — Wallace B. Reynolds
Assistant Director — William M. Brobeck
Director, Crocker Laboratory—Medical Physics — Dr. Joseph G. Hamilton
Director, Donner Laboratory of Medical Physics — Dr. J. H. Lawrence
Assistant Director, Donner Laboratory — Dr. Hardin Jones

Raw Materials Development Laboratory (American Cyanamid Co., contractor), Winchester, Mass.

Director — Daniel M. Kentro
Assistant Director — Hugh H. Bein

Rochester Atomic Energy Project (University of Rochester, contractor), Rochester, N. Y.

Director — Dr. Henry A. Blair
Assistant Director for Education — Dr. J. Newell Stannard
Business Manager — C. M. Jarvis

Sandia Laboratory (Sandia Corp., contractor), Sandia Base, Albuquerque, N. Mex.

President — Donald A. Quarles

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

APPENDIX 4

Isotope Distribution Data

	Number of Shipments[1]		
	Aug. 2, 1946, June 30, 1952	July 1, 1952, May 30, 1953	Total to May 30, 1953
Shipments classified by kind of isotope:			
Radioactive isotopes:			
Iodine 131	10,468	3,834	14,302
Phosphorus 32	7,982	1,973	9,955
Carbon 14	1,235	340	1,575
Sodium 24	1,058	320	1,378
Sulfur 35	603	139	742
Gold 198, 199	787	411	1,198
Calcium 45	419	70	489
Iron 55, 59	366	113	479
Cobalt 60	562	162	724
Potassium 42	457	130	587
Strontium 89, 90	199	104	303
Other	3,578	1,229	4,807
Total	27,714	8,825	36,539
Stable Isotopes:			
Deuterium oxide (heavy water)	608	14	622
Deuterium (hydrogen 2)	503	127	630
Boron 10 and 11	140	36	176
Helium	16	11	27
Oxygen 18	107	134	241
Electromagnetic concentrated	589	107	696
Argon 38	1	2	3
Total	1,964	431	2,395
Shipments to AEC Installations:			
Radioactive	5,702	917	6,619
Stable	1,337	211	1,548

[1] Shipments from Oak Ridge National Laboratory, Oak Ridge, Tenn.

259630—53——7

LOCATION AND TYPE OF ISOTOPE USERS [2]

Aug. 2, 1946–May 30, 1953

States	Medical Institutions and Physicians		Colleges and Universities		Industrial Firms		Federal and State Labs.		Foundations and Institutes		Other		Total	
	Radioactive	Stable	Radioactive	Stable	Radioactive	Stable	Radioactive	Stable	Radioactive	Stable	Radioactive	Stable	Radioactive	Stable
Alabama	4		2	1	7		2	1	1	1			16	3
Alaska	1		1				1						3	
Arizona	2		1				2						5	
Arkansas	4		1	1	2								7	1
California	68	4	15	10	69	11	32	4	2	1			186	30
Colorado	11		3	2	4		3		1		1		23	2
Connecticut	9	1	5	3	23	3	2						39	7
Delaware			1	1	8	2			1	1			10	4
District of Columbia	7	4	3	4	5		12	4			1		28	12
Florida	7		4	1	1		3						15	1
Georgia	6		4	3	3		6						19	3
Hawaii	3						1		2				6	
Idaho	1		1		1								3	
Illinois	33	3	7	6	39	6	13	1	2	1	1		95	17
Indiana	10		3	3	21	3					1		35	6
Iowa	2	1	2	2	4								8	3
Kansas	9		2	2	3								14	2
Kentucky	3		1	1	4		3		1				12	1
Louisiana	6	1	3	2	6	2	1						16	5
Maine	2		3		5		1						11	
Maryland	10	4	5	3	11	2	9	5					35	14
Massachusetts	24	7	10	7	49	9	6	2	3	1	1		93	26
Michigan	14	1	7	3	24	5	1						46	9
Minnesota	7	2	5	2	8		1						21	4
Mississippi	2		1		1		3	1					7	1
Missouri	18	1	4	4	3		1						26	5
Montana	3	2	1	1			1						5	3
Nebraska	3		1				1						5	
Nevada					2		1						3	
New Hampshire	1		2	1	3		2						8	1
New Jersey	5		4	2	56	11	5	1	6	1		2	76	17
New Mexico	5		2	1			2						9	1
New York	87	12	24	18	84	11	12	1	7		1		215	42
North Carolina	7	1	5	3	3		4						19	4
North Dakota	5		2				1						8	
Ohio	20	2	8	3	61	5	8	2	2	2			99	14
Oklahoma	4		1	1	16	5	1		3				25	6
Oregon	3	1	3	3	2		2						10	4

Panama							1						1	
Pennsylvania	32	5	10	6	72	12	9	2	4	3			127	28
Puerto Rico	3						2						5	
Rhode Island	1		2	1	6		1						10	1
South Carolina	2		2		1		1						6	
South Dakota			2										2	
Tennessee	15	1	4	3	7	1	4	1					30	6
Texas	28	6	4	4	37	6	4		4	1		1	77	18
Utah	3	1	3	1	2		2						10	2
Vermont	3				1								4	
Virginia	4		4	1	7	1	8						23	2
Washington	9		4	2	7		4						24	2
West Virginia	6		2	1	2	1	1						11	2
Wisconsin	6	1	1	1	20		3						30	2
Wyoming			1				1						2	
Total	518	61	186	115	690	96	184	25	39	12	6	3	1,623	312

[2] Users are either institutions or individuals receiving isotopes authorized through the Commission's distribution program.

FOREIGN SHIPMENTS OF RADIOISOTOPES[1]

Country	Radioactive	Stable
Argentina	92	....
Australia	101	....
Austria	1	....
Belgium	125	....
Bermuda	16	....
Brazil	166	....
British West Africa	1	....
Canada	248	....
Chile	70	....
Colombia	5	....
Costa Rica	0	....
Cuba	82	....
Denmark	192	....
Dominican Republic	1	....
Egypt	1	....
El Salvador	0	....
England	125	....
Finland	10	....
France	81	....
Guatemala	0	....
Germany	2	....
Iceland	4	....
India	10	....
Ireland	0	....
Israel	2	....
Italy	21	....
Japan	169	....
Lebanon	6	....
Mexico	22	....
Netherlands	51	....
New Zealand	11	....
Norway	42	....
Pakistan	5	....
Paraguay	0	....
Peru	10	....
Portugal	4	....
Spain	5	....
Sweden	176	....
Switzerland	49	....
Syria	0	....
Trieste	3	....
Turkey	5	....
Union of South Africa	28	....
Uruguay	10	....
Total	1,952	....
KIND OF ISOTOPE		
Phosphorus 32	679	....
Iodine 131	497	....
Carbon 14	209	....
Sulfur 35	86	....
Iron 55, 59	74	....
Cobalt 60	111	....
Calcium 45	66	....
Strontium 89, 90	47	....
Other	183	....
Total	1,952	....

[1] Total number of shipments to May 30, 1953.

APPENDIX 5

Regulations of the U. S. Atomic Energy Commission[1]

Part 80—General Rules of Procedure on Applications for the Determination of Reasonable Royalty Fee, Just Compensation; or the Grant of an Award for Patents, Inventions or Discoveries

Promulgated 18 June 1948, 13 F. R. 3457, as amended 1 Feb. 1953, 18 F. R. 619.

GENERAL PROVISIONS

§ 80.1 *Scope of the regulations.* The regulations in this part provide the rules of procedure to be followed by any person making application to the Atomic Energy Commission for the determination of a reasonable royalty fee, just compensation, or the grant of an award, and for the consideration of such applications pursuant to subsection (e) of section 11 of the Atomic Energy Act of 1946 (60 Stat. 755, 768; 42 U. S. C. 1811).

§ 80.2 *Definitions.* (a) All terms used in the regulations in this part which are defined in the Atomic Energy Act shall have the defined meaning.

(b) "Board" shall mean the Patent Compensation Board designated by the Commission pursuant to subsection (e) (1) of section 11 of the act.

(c) "Application" shall mean the application provided for in §§ 80.10 to 80.12, inclusive.

(d) "Response" shall mean the document, to be filed by the Office of the General Counsel of the Commission, provided for in § 80.22.

[1] Policies and regulations of the U. S. AEC announced prior to July 1952 can be found in Appendix 4, Fifth Semiannual Report to Congress; Appendix 10, Sixth Semiannual Report to Congress; Appendix 4, Ninth Semiannual Report to Congress; Appendix 6, Tenth Semiannual Report to Congress; Appendix 6, Eleventh Semiannual Report to Congress; Appendix 6, Twelfth Semiannual Report; Appendix 6, Thirteenth Semiannual Report; and in the *Federal Register.*

(e) "Party" shall mean the applicant (personally or through his counsel) and the Office of the General Counsel of the Commission, as the text may indicate. Each applicant shall be entitled to be represented by counsel.

§ 80.3 *Notices.* All notices required by this part and the service of all documents will be by registered mail and will be effective as of the time received.

§ 80.4 *Security.* In any proceeding under the regulations in this part, the Commission may issue any general or specific order, directive, or further regulation which it determines to be appropriate pursuant to section 10 of the act to assure the common defense and security.

§ 80.5 *Amendment.* Nothing in this part shall limit the authority of the Commission to issue or amend its regulations in accordance with law.

§ 80.6 *Records of Board.* The records of the Board in cases filed before it, including the application, the response, the transcript and any other portion of the record, shall be open to public inspection unless (a) the Board otherwise directs upon a determination that opening of the records to public inspection would be contrary to the public interest or, (b) opening of the records is not in accord with security regulations and requirements of the Commission.

§ 80.7 *Motions.* Motions may be made before the Board upon reasonable notice to the other parties.

APPLICATIONS

§ 80.10 *Applicants.* (a) Any person claiming just compensation for any patent revoked in whole or in part by paragraph (1) and (2) of subsection (a) or by subsection (b) of section 11 of the act may file an application for just compensation.

(b) Any person claiming just compensation for any invention or discovery, or for any patent or patent application covering such invention or discovery, taken, requisitioned, or condemned by the Commission pursuant to subsection (d) of section 11 of the act may file an application for just compensation.

(c) Any person claiming a reasonable royalty fee for the use of an invention or discovery covered by any patent declared to be affected with a public interest pursuant to paragraph (1) of subsection (c) of section 11 of the act, or any person who has been licensed pursuant to section 11 (c) (2) of the act to utilize the invention or discovery covered by such patent and is unable to reach an agreement with the owner thereof, may file an application for the determination of a reasonable royalty fee.

(d) Any person who has made any invention or discovery covered by paragraph (3) of subsection (a) of section 11 of the act, who is not entitled to compensation therefor under subsection (a) of section 11, and who has complied with the provisions of paragraph (3) of subsection (a), may file an application for an award.

§ 80.11 *Form and content.* (a) Each application shall be signed by the applicant and shall state his name and post office address. Where the applicant elects to be represented by counsel, a request for entry of counsel's appearance shall be filed with or after the application, on a form obtainable from the Clerk of the Board.

(b) Each application shall contain a statement of the applicant's interest in the patent, patent application, invention or discovery, identifying any other claimants of whom the applicant has knowledge.

(c) Each application must contain a concise statement of all of the essential facts upon which it is based. No particular form of statement is required, but it will facilitate consideration of the application if the following specific data accompany the application:

(1) In the case of an issued patent, a copy of the patent;

(2) In the case of a patent applica-

tion, a copy of the application and of all Patent Office actions and responses thereto;

(3) In the case of an invention or discovery as to which a report has been filed with the Commission pursuant to paragraph (3) of subsection (a) of section 11 of the act, a copy of such report.

(4) The date relied upon as the date of invention.

(5) In all cases, a statement of the extent to which, if any, the invention or discovery was developed through federally financed research; the degree of its utility, novelty, and importance.

(6) In the case of an application for just compensation or an award, a statement of the actual use of such invention or discovery, to the extent known to the applicant.

(7) In all cases, the cost of developing the invention or discovery or acquiring the patent or patent application.

(8) The reasonable royalty fee proposed, or the amount sought as just compensation or award; the basis used in calculating it; and whether lump sum or periodic payments are sought.

(d) Each connected series of statements shall be set forth in separately numbered paragraphs in the application. Any exhibits or documents which accompany the application may be incorporated by reference.

(e) All applications shall be verified by the applicant or by the person having the best knowledge of such facts. In the case of facts stated on information and belief the source of such information and grounds of belief shall be given.

§ 80.12 *Filing of applications.* (a) Five copies of each application shall be filed with the Clerk of the Board. At the applicant's election, only one copy of the accompanying exhibits need be filed.

(b) The Clerk of the Board will acknowledge the receipt of the application in writing and advise the applicant of the docket number assigned to the application.

(c) All communications concerning the application and all documents thereafter filed in the proceeding shall bear the docket number of the application.

EXAMINATION AND RESPONSE

§ 80.20 *Examination.* Upon receipt of the application, a preliminary examination will be made by the Commission staff.

§ 80.21 *Recommendation for acquisition by purchase.* At any time following the filing of an application and prior to final determination, the applicant may be requested in writing to meet with one or more members of the Commission staff to discuss the possibility of acquisition by purchase of the invention or discovery or patent or patent application, as the case may be, pursuant to subsection (d) of section 11 of the act. The time prescribed in § 80.22 for the filing of the response shall be extended by a time equivalent to any period in which negotiations are being conducted (beginning with the initial communication to the applicant and ending either with acceptance or rejection of a proposal or with a written communication by the applicant stating that negotiations are to be terminated).

§ 80.22 *Response.* Within a reasonable time and in no event more than four (4) months after receipt of the application, unless such time shall have been extended by special order of the Board for cause or pursuant to § 80.21, the Office of the General Counsel shall file with the Clerk of the Board a response containing a concise statement of the facts or law constituting a defense or any other relevant matter which it believes should be considered by the Board.

PREHEARING CONFERENCE

§ 80.30 *Designation.* In any proceeding in which the Board in its discretion determines that a prehearing conference would be desirable, the Board may designate one of its members to preside at a prehearing conference to which the parties shall, upon reasonable notice, be invited to appear.

§ 80.31 *Conference procedure.* (a) The prehearing conference shall be conducted in an informal manner and shall be devoted to a consideration of

(1) The simplification of the issues;

(2) The necessity or desirability of amendment or amplification of the application or the response;

(3) The possibility of obtaining agreement as to facts and documents which will avoid unnecessary proof;

(4) Such other matters as may facilitate the consideration by the Board.

(b) The Board member presiding at such conference shall prepare, with the assistance of the parties, a memorandum of matters upon which agreement has been reached, and such memorandum shall, when signed by the parties, become a part of the record.

HEARING

§ 80.40 *Notice.* The Board shall in each case afford an opportunity for hearing for the receipt of relevant evidence. At least thirty (30) days notice shall be given of the time and place of such hearing.

§ 80.41 *Order of procedure.* Ordinarily evidence in support of the application shall be received first and thereafter evidence in reply. Thereafter rebuttal and any necessary additional evidence shall be received.

§ 80.42 *Submission and receipt of evidence.* (a) Each witness shall, before proceeding to testify, be sworn or make affirmation.

(b) When necessary in order to prevent undue prolongation of the hearing, the Board may limit the amount of corroborative or cumulative evidence, may restrict the repetitious examination or cross-examination of witnesses, and shall otherwise control the conduct of the proceeding.

(c) The Board shall admit only relevant and material evidence.

(d) Opinion evidence shall be admitted when the Board is satisfied that the witness is properly qualified.

(e) Evidence may be received in affidavit form in the discretion of the Board. All affidavits shall be submitted not later than the opening of the hearing unless the Board for cause shown shall receive them at a later time. Each party shall be permitted to examine all affidavits received in evidence, and to file counter affidavits within such period as the Board shall fix. In determining the weight to be attached to testimony contained in affidavits, the Board shall consider the lack of opportunity for cross-examination.

(f) Opportunity shall be afforded for the cross-examination of witnesses. Objections to the admission or rejection of any evidence or to any limitation of the scope of examination or cross-examination shall state briefly the grounds of such objection and the transcript shall not include argument on such objection except as ordered by the Board. No objection may subsequently be relied upon unless timely made, and the ruling on each objection shall be made part of the transcript, together with any offer of proof which may be made.

(g) In the conduct of the hearing the Board shall ensure compliance with the security regulations and requirements of the Commission and take whatever steps it may deem appropriate to assure the common defense and security pursuant to the provisions of the act.

§ 80.43 *Transcript of the testimony.* Testimony given at a hearing shall be reported verbatim. All written statements, charts, tabulations, and similar data offered in evidence at the hearing shall be marked for identification and, upon a showing satisfactory to the Board of their authenticity, relevance, and materiality, shall be received and marked as exhibits in evidence. Such exhibits (including affidavits) shall, if practicable, be submitted in quintuplicate. Where the required number of copies are not made available, the Board may in its discretion order the exhibit read in evidence or require additional copies to be submitted within a specified time.

§ 80.44 *Oral arguments; proposed findings; written arguments.* (a) In its discretion the Board may authorize oral argument at the close of the hearing.

(b) The Board may, at its discretion, announce at the hearing a reasonable period within which either party may submit to the Board proposed findings and a proposed recommendation. Such proposals shall be in writing, in quintuplicate, and copies shall be served on the opposing party.

(c) At the time fixed for the submission of proposed findings, either party may file written arguments in support based upon the evidence received at the hearing, citing the page or pages of the transcript of the testimony where such evidence may be found.

§ 80.45 *Copies of the record of the hearing.* The Board shall make provision for a stenographic record of the testimony and for furnishing it to the applicant upon payment of the cost. Suggested corrections to the transcript of the testimony shall be considered only if filed within a period to be fixed by the Board. Upon receipt of such suggested corrections, the Board in its discretion shall correct the transcript.

PROPOSED FINDINGS AND DETERMINATION

§ 80.50 *Formulation.* (a) Within a reasonable time after the close of the hearing the Board shall prepare and serve upon the parties its proposed findings and proposed determination, and a statement of the reasons or basis therefor. The proposed findings and proposed determination shall be based upon the entire record and supported by reliable, probative, and substantial evidence. On issues of fact, no finding shall be proposed except when deemed by the Board to be supported by the greater weight of the evidence. The proposed findings and proposed determination, together with the statement of the reasons or basis therefor, shall become part of the record.

(b) The Board shall further make a ruling upon each proposed finding and proposed recommendation presented by either party pursuant to § 80.44 (b). Such rulings shall be served upon each party and shall become part of the record.

§ 80.51 *Exceptions.* Either party may, within twenty (20) days after receipt of a copy of the proposed findings and proposed determination of the Board, unless such time shall have been extended by special order of the Board for cause, file with the Clerk of the Board exceptions to any part thereof or to the failure of the Board to include proposed findings requested under § 80.44. The exceptions may be accompanied by briefs in support. Five (5) copies of the exceptions and the supporting briefs shall be filed, and a copy served upon the other party. The exceptions but not the supporting briefs shall become part of the record.

ADJUDICATION

§ 80.60 *Final action.* (a) Upon the expiration of the period prescribed in § 80.51, the Board shall proceed to a final consideration of the application on the basis of the entire record, including any exceptions, and the briefs in support filed by either party. The Board shall resolve questions of fact by what it deems to be the greater weight of the evidence and shall make its decision on the entire record. Its findings as to the facts shall be supported by reliable, probative and substantial evidence. The Board shall enter an appropriate order, together with a statement of its reasons or basis, determining as the case may be a reasonable royalty fee, the amount of just compensation, or the amount of an award, or such other disposition as its determination requires.

(b) The Board shall further make a ruling upon each exception presented by either party pursuant to § 80.51.

(c) The order of the Board shall constitute the final action of the Commission.

APPENDIX 6

TABLE OF THE UNSTABLE ELEMENTARY PARTICLES

NAME	POSSIBLE DECAY PRODUCTS	LIFETIME (seconds)	MASS (units of electron mass)	REMARKS
$V_1^{\pm}$ particle	proton$+\pi^0$	(?)	2200(?)	A few cloud chamber tracks have been observed. The only experimental examples of charged V_1 particles are positive, but the analogous V_1^- may also occur.
V_1^0 particle	proton$+\pi^-$	2.5×10^{-10}(?)	2190	Existence well established. Has been produced by Cosmotron.
neutron	proton+electron+neutrino	740	1837	A well known particle.
V_4^0 particle	$\kappa^+ + \pi^+$ perhaps also $\kappa^+ + \pi^-$	(?)	(?)	Only a few cloud chamber tracks have been observed.
$S^{\pm}$ particle	$\pi^{\pm}+$ (a neutral?)	10^{-8}–10^{-9}	1480(?)	The existence of these particles seems established but their masses and lifetimes are uncertain. Collectively these particles are sometimes referred to as K particles.
$\chi^{\pm}$ meson	$\pi^{\pm}+$(a neutral?)	10^{-8}–10^{-9}	1400(?)	
$V^{\pm}$ meson	$\pi^{\pm}$ or $\mu^{\pm}$	(?)	800–1100	
$\kappa^{\pm}$ meson	$\mu^{\pm}+$(2 neutral?)	(?)	800–1100	
$\tau^{\pm}$ meson	$\pi^{\pm}+\pi^{+}+\pi^{-}$	10^{-8}–10^{-9}	975(?)	Observed as three charged particles which decay from a charged particle.
V_2^0 particle	$\pi^{+}+\pi^{-}$	10^{-10}(?)	972(?)	Observed in a cloud chamber as two charged particles which decay from a neutral particle.
ζ^0 particle(?)	$\pi^{+}+\pi^{-}$	10^{-14}(?)	556(?)	The evidence for their existence may have other interpretations.
$\zeta^{\pm}$ particle(?)	$\pi^{\pm}+(\pi^0$?)	10^{-11}(?)	552(?)	The evidence for their existence may have other interpretations.
$\pi^{\pm}$ meson	$\mu^{\pm}+$neutrino	2.6×10^{-8}	276	Very well established: Found in cosmic rays and produced artificially by high energy accelerators.
π^0 meson	2γ	5×10^{-15}(?)	266	Well established: Found in cosmic rays and produced artificially by high energy accelerators.
$\mu^{\pm}$ meson	electron+2 neutrinos positron+2 neutrinos	2.15×10^{-6}	212	Decay product of π meson. Well established.

Only those particles about which there is some agreement are listed in this table. Some of the entries in the table are likely to be changed as further information is accumulated.