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BOX # 2631

EXTRACT: FROM OAK RIDGE OPERATIONS

# INFORMATION MANUAL



ATOMIC ENERGY COMMISSION · UNITED STATES OF AMERICA

BUDGET AND REPORTS DIVISION

October 1953 Prod. Sheet 2631

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ORNL Programs-Contd.

a. The chemistry of nuclear reactors.
b. General separations technology associated with radioactive materials.
c. Chemical methods for the separation of isotopes.
d. Chemistry of uranium raw materials.
e. Instrumentation and hot laboratory research.

One of the current programs under category b, for example, is Thorex - a chemical development program for the separation of U-233, Pa-233, and the recovery of thorium from irradiated thorium metal. This process study was initiated at ORNL during FY 1952 and will probably be taken through the pilot plant demonstration phase during FY 1955. The Thorex process is of importance for the fissionable U-233 which it separates, of course, but will also be of importance in connection with converters and breeder type reactors which may be developed with thorium as the breeding material.

## Program 6000
## Biology and Medicine

Oak Ridge National Laboratory cooperates closely with (a) Argonne National Laboratory on research with chemical compounds of promise as materials providing radiation protection to living organisms, (b) project "Greenhouse" in establishing the danger from atomic bomb explosion; (c) other AEC Laboratories on the use of isotopes in metabolism studies and in ion-exchange methods for preparation of special products; (d) the British Atomic Energy Project in the study of mouse genetics and related fields; (e) the Armed Forces Institute of Pathology; (f) National Institutes of Health; (g) the pathology and physiology group of the U. S. Navy; (h) the Isotope Division of AEC by supplying labeled sugars for sale; (i) Southern Universities; (l) Oak Ridge Institute of Nuclear Studies; and (k) with the Division of Biology and Medicine in a program of biological experiments at the Nevada Proving Ground.

### Mouse Genetics

Mice of known hereditary characteristics are being used to investigate the long-term effects of exposure to radiations. Three different dose levels of x-irradiation are currently used for the evaluation of herediatry effects in mice for comparison with what is presently known in less-complicated animal species. With knowledge gained by these experiments, it is expected that a better prediction of the effects of human exposure to radiation can be made. To this program is added an investigation of damage to the mouse embryo by x-irradiation applied to the pregnant mother. These studies at ORNL of radiation effects upon various stages of the mouse embryo during development can be in part correlated with recent reports of damage to the human embryo shown through studies of surviving infants in Hiroshima. This program is being extended to incorporate an evaluation of neutron effects.

ORNL Programs-Contd.

Cytogenetics

Among the more notable effects of radiation upon living material are the chromosome breaks and aberrations and other changes within the nucleus of the living cell. These may cause damage in critical organs, block of cell division, failure of tissue growth and function, or changes in the hereditary constitution of surviving cells. The degree to which such changes occur in the nucleus also serves as a clue to the dosage for many forms of radiation. These effects are under investigation in several plant and animal species, and studies are in progress to determine the extent to which diffusing oxygen and changes in humidity alter this cell damage. This field of study also involves the examination of changes in rates of cell division, survival, reproduction and death in the protozoan, Paramecium, in the fruit-fly, Drosophila, in the Tradescantia plant and in grasshopper neuroblasts as a result of irradiation, using these several organisms as versatile tools.

Radiation Protection

A survey is being made of chemical compounds which promise to be useful in causing a degree of protection against radiation damage in living material. These have been tested on microorganisms, principally bacteria, and preliminary experiments show that some of them may be used for radiation protection in the mammal.

Biochemistry

Through the use of ion-exchange methods, the chemical nature of nucleic acids is being determined in preparation for an extensive study of the mode of nucleic acid disruption as a result of irradiation. The nucleic acids are components of nucleo-proteins which are themselves the substances which make up the nuclear structure of cells and the genetic material which controls heredity in all living organisms. Studies are also in progress to determine the synthetic pathways in plant and animal cells for the building of compounds useful in cell structure or for the gain of energy by the organism. From this work, a portion of which is accomplished through use of tagged atoms, new concepts are emerging as to the nucleic acid structure of proteins and the pathways by which the living cell makes use of 2- and 4-carbon organic acids for producing source of potential energy.

Pathology and Physiology

Long-term effects due to exposure to all kinds of ionizing radiations, such as cancer-indiction, cataract development, and other radiation-induced diseases, are under study in the pathology and physiology section of ORNL. In addition to this, the immediate action of high-level radiation upon whole organ systems is under investigation in the laboratory mammal. This includes the determination of changes in endocrine function, the premeability of the blood-vascular system, the lymphatic system, and in the production of diseases such as leukemia as a result of exposure to radiations.

ORNL Programs-Contd.

## Reactor Development - Supplement

### School of Reactor Technology

The School of Reactor Technology was established for the purpose of training engineers and scientists in the field of reactor theory and technology, in preparation for their engaging directly in reactor research and/or development. This represents an effort to enable appropriate governmental agencies, their contractors, and private industrial organizations to participate actively in this new and important field of industrial development and to stimulate more effective participation in those organizations already actively engaged in the field. Of equal importance, the School accepts selected recent college engineering graduates for supplementary training specifically in reactor development work and thus provides a new source of young trained personnel for the AEC reactor development program.

The first formal class of ORSORT, 26 representatives from industry and 20 graduate students, completed the 1950-51 session in August 1951. The second class, 30 representatives from industry and 38 graduate students completed the 1951-52 session in August 1952. The 1952-53 class included 31 graduate student and 50 representatives of industry and government agencies. The class of 1953-54 includes 32 graduate students and 48 representatives of industry and government agencies. It is expected that the School enrollment will be maintained at a level of 80 during the 1954-55 session.

[redacted]

ORNL Programs-Contd.

Health Physics

The Health Physics program at ORNL does not greatly change from year to year in fields of development supporting routine protection to laboratory personnel or in the general area protection against radiation hazards. However, in health physics education, in the development of new instrumentation, and in application to immediate research problems, the program does change to some degree as new procedures and needs arise.

Health Physics at ORNL has started, organized, and distributed information that aids in the establishment of maximum levels for radiation exposure and radioactive contamination in plant and laboratory. New instruments and techniques have been developed for radiation measurement, especially in the field of neutron dosimetry, and in the analysis of radioactive constituents present in inorganic and organic material of importance to health. Survey, laboratory, and pilot-plant studies are in progress on dispersion, localization and behavior of radioactive wastes in water supply systems and in lakes and streams. A pilot plant investigation is being made on adaptation of routine sanitary engineering and water-treatment processes to the concentration and removal of radioactive materials from water supplies. In conjunction with studies being completed by TVA, the conditions of the limnology, botany the fish population, and the food organisms of Whiteoak Lake and the Clinch River are under investigation with respect to detection of any possible effect of radioactive contamination. To date no gross changes have been identified as a result of chemical waste entering Whiteoak Creek from the ORNL area.

The Health Physics Division has developed methods for assaying uranium and plutonium in air and water and in biological fluids, and undertaking a program on studies of particle size and particle distribution in air. The purpose of this latter program is to determine more accurately the nature of radioactive materials which escape into the atmosphere from various operations, their control, and evaluation of the means for removal by use of filters and precipitators. A program of services to all laboratory groups is always in operation to advise and consult on such problems as the coordination of health physics requirements with the construction of new facilities, the improvement of instrumentation for constant air-monitoring equipment, evaluation of radiation hazard in operations and experiments, the estimation of shielding requirements for experimental facilities, improvements in decontamination procedures, design of reactor safety features, and in the improvement of radiation protection education.

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ORNL Programs-Contd.

The Health Physics Division of ORNL actively cooperates with all agencies and installations interested in radiation protection, including the other national laboratories, the United States Public Health Service, the U. S. Geological Survey, The Tennessee Valley Authority, the U. S. Army Corps of Engineers, the Oak Ridge Institute of Nuclear Studies, and the U. S. Air Force.

Radioactive wastes have been confined and controlled, surface and airborne contamination is detected, controlled, and evaluated at a high standard of radiation dosimetry. The excellent radiation safety record of the laboratory is largely attributable to the attention, study, and education of this division.

Source: ORNL Research and Development Program for FY 1954 (supporting program information for ORNL budget estimates contained in KAD-132 dated March 27, 1952), Oak Ridge National Laboratory, May 27, 1952, ORO. Research and Medicine Division.

# OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

## Contract

The Oak Ridge Institute of Nuclear Studies is a non-profit educational corporation, comprised of thirty southern universities, organized to conduct a nonclassified program of research and training in the nuclear sciences and the AEC fellowship program at Oak Ridge. It operates under a cost-plus-no-fee contract which runs to 1957 with the Atomic Energy Commission. The Institute maintains informal agreements with other Oak Ridge Operations contractors which permit the use of Oak Ridge research and training facilities in programs of interest to universities.

## Sponsors

The ORINS sponsoring institutions are: Agriculture and Mechanical College of Texas, Alabama Polytechnic Institute, Catholic University of America, Clemson University, Duke University, Emory University, Florida State University, Georgia Institute of Technology, Louisiana State University, Mississippi State College, North Carolina State College, Rice Institute, University of Alabama, University of Arkansas, University of Florida, University of Georgia, University of Louisville, University of North Carolina, University of Oklahoma, University of Puerto Rico, University of South Carolina, University of Tennessee, University of Texas, University of Virginia, Tulane University of Louisiana, Vanderbilt University, and Virginia Polytechnic Institute.

## Operations

The Institute operates the following facilities in Oak Ridge: a training building which houses laboratories and classrooms for the Radioisotope Training Program and the Resident Graduate Program; a medical building which houses research laboratories and clinical facilities for research and treatment of malignant diseases, primarily cancer; a technical library; and the American Museum of Atomic Energy.

## Organization

The Institute consists of a Council composed of one representative of each of its thirty sponsoring institutions, a Board of Directors elected by the Council to administer the Institute program, and a resident Executive Director of the Institute. Under the Executive Director is a staff of approximately 100 persons in the administrative and program divisions. The program divisions are: University Relations, Medical, Special Training, and Museum.

## Activities

Through the research participation program, university scientists participate in the Oak Ridge research program for periods of three months or longer.

More than one thousand scientists have been trained in the safe and efficient use of radioisotopes through the radioisotope training program of the Institute.

### Cancer Research

The Institute in cooperation with the southern medical schools conducts a long-range study of the effects of atomic energy materials on cancer, utilizing a 30-bed hospital and laboratory unit. Patients are admitted for treatment only through a medical school.

The Medical Division is one of three major medical programs supported by the Atomic Energy Commission. The other two are at Brookhaven National Laboratory and Argonne National Laboratory.

The Division has carried out a comprehensive investigation of the use of Gallium$^{72}$ in cancer therapy. This isotope which is attracted by bony tissue, was originally thought to be of value in bone tumors, although this has not proved to be the case. The Division is investigating Gallium$^{67}$, another isotope which has considerably different relation characteristics and is available in much higher purity than was possible with Gallium$^{72}$. (See section on radioisotopes for additional data.)

Along with many other hospitals, the Institute is doing extensive studies with radioactive gold in treating internal cancers which result in fluid formation. This formation of fluid is frequently one of the most disabling symptoms of the disease, and good results are being produced, although the course of the cancer itself is not reversed and the treatment is palliative only.

The Medical Division is one of the leaders in the rapidly-developing field of teletherapy units which utilize various radioisotopes as powerful sources for external irradiation of cancer. The first such source, a 1250-Curie cobalt units, is the "hottest" piece of metal ever known. It has been loaded in a teletherapy unit at the division for testing and eventual transfer to the M. D. Anderson Memorial Hospital for Cancer Research in Houston, Texas. The Medical Division will play the central role in a full-scale testing program of a teletherapy unit utilizing either cobalt, cesium, or europium. This unit is still in the planning stage.

## Museum

The American Museum of Atomic Energy is operated by the Institute as a public service in the field of education. The Museum contains exhibits and other nonclassified materials concerning the atomic energy program. As of June 30, 1952, more than 200,000 visitors had toured the Museum. The Institute provides traveling exhibits from the Museum for scientific meetings and similar activities.

## Graduate Program

The Oak Ridge graduate program is available for selected graduate students from any university in the country to carry out research for the doctoral degree in the nuclear sciences at the Oak Ridge research laboratories.

The Institute administers the AEC fellowship program for sponsored predoctoral and postdoctoral research in the physical, biological, and medical sciences in the universities of the students' choice.

Through the traveling lecture program, Oak Ridge scientists lecture, conduct seminars, and take part in other educational activities on university campuses.

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Oak Ridge Institute of Nuclear Studies
NET OPERATING EXPENSES BY PROGRAMS
(Activities Financed by the Government)
Fiscal Years 1951, 1952 and 1953

| Program | FY 1951 | FY 1952 | FY 1953 |
|---|---|---|---|
| Total Operating Expenses | $970,828 | $1,752,514 | $1,568,329 |
| University Relations Division | $254,079 | $1,008,263 | $ 735,373 |
| Resident Graduate Program | 27,410 | 17,610 | 32,194 |
| Oak Ridge Graduate Program | 38,462 | 32,508 | 28,749 |
| Research Participation Prog. | 43,517 | 45,531 | 51,208 |
| AEC Fellowship-Life Sciences | 45,814 | 249,001 | 170,172 |
| AEC Fellowship-Phy. Sci. | | 559,669 | 327,415 |
| Radiological Physics Fellows | 98,876 | 103,944 | 125,635 |
| Medical Division | | | |
| Cancer Research Program | $447,422 | $453,302 | $530,018 |
| Special Training Division | $176,081 | $182,014 | $175,064 |
| Special Training Program | 129,634 | 123,496 | 134,145 |
| Other Training Activities | 46,447 | 58,518 | 40,919 |
| Exhibits Division | | | |
| American Museum of Atomic Energy - Gross | $108,706 | $150,400 | $177,164 |
| American Museum of Atomic Energy - Revenue | - 15,460 | -41,465 | -49,290 |
| American Museum of Atomic Energy - Net | $ 93,246 | $108,935 | $127,874 |

Source: Research and Medicine Division.

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# AMERICAN MUSEUM OF ATOMIC ENERGY

The American Museum of Atomic Energy program at Oak Ridge, administered for the Atomic Energy Commission by the Oak Ridge Institute of Nuclear Studies, comprises a basic unit where, in addition to exhibits for the education of the general public, facilities are provided for the fabrication and maintenance of exhibit materials for all phases of the program. Mobile exhibits, prepared at Oak Ridge, reach a large segment of the population in response to requests from educational institutions, industry, state fairs, and expositions. Such exhibits are sent out from Oak Ridge in Museum-operated tractor-trailer vans, or are supplied in poster or package form with layout instructions.

a. Location of Museum:

The Museum was established in 1949 at the time the City of Oak Ridge was opened to the public. Oak Ridge and atomic energy being synonymous in the public mind, the community was felt to be the natural location for a museum which would serve to educate the large numbers of persons whose primary interest is in learning about atomic energy and who would come to Oak Ridge as the logical source of information on the subject. An economic consideration was and is the availability of a Government-owned facility at Oak Ridge feasible for conversion and use to house an adequate museum. The proximity to the large research laboratories at Oak Ridge is a major factor in keeping the exhibits abreast of current developments in the field of Atomic Energy. The significant increase in visitor registration is a measure of the success of the Museum in its present location. Attendance has almost doubled from 42,077 in FY 1950, the first full year of operation, to 79,017 in FY 1953.

b. Visitors and Sources:

Visitors during FY 1953 registered from every state in the Union and many foreign countries. Numerous schools included a tour of the Museum in their educational programs. Visitor distribution by source was as follows:

| | | | | | |
|---|---|---|---|---|---|
| Alabama | 1,906 | Illinois | 6,171 | Minnesota | 321 |
| Arizona | 314 | Indiana | 6,287 | Mississippi | 1,033 |
| Arkansas | 553 | Iowa | 638 | Missouri | 1,503 |
| California | 1,426 | Kansas | 573 | Montana | 119 |
| Colorado | 435 | Kentucky | 3,721 | Nebraska | 197 |
| Connecticut | 625 | Louisiana | 949 | Nevada | 193 |
| Delaware | 323 | Maine | 387 | New Hampshire | 209 |
| Florida | 1,868 | Maryland | 623 | New Jersey | 657 |
| Georgia | 3,013 | Massachusetts | 554 | New Mexico | 172 |
| Idaho | 398 | Michigan | 3,958 | New York | 2,412 |



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| | | | | | |
|---|---|---|---|---|---|
| North Carolina | 2,898 | Rhode Island | 170 | Vermont | 35 |
| North Dakota | 200 | South Carolina | 1,702 | Virginia | 1,672 |
| Ohio | 14,797 | South Dakota | 1,133 | Washington | 76 |
| Oklahoma | 1,042 | Tennessee | 6,612 | West Virginia | 1,115 |
| Oregon | 191 | Texas | 1,738 | Wisconsin | 1,265 |
| Pennsylvania | 1,913 | Utah | 48 | Wyoming | 95 |

| | |
|---|---|
| Washington, D.C. | 497 |
| Alaska | 9 |
| Hawaii | 6 |

The remaining 339 visitors originated outside the United States, and registered at the Museum during the FY 1953, as follows:

| | |
|---|---|
| Canada | 121 |
| South America | 9 |
| Continental Europe | 143 |
| Great Britain, Australia and New Zealand | 30 |
| Africa and Asia | 36 |

166 school groups, mainly of Junior and Senior School age also visited the Museum, averaging from 30 to 40 pupils per group, and coming from the following states:

| | | | |
|---|---|---|---|
| Alabama | 2 | New Jersey | 1 |
| Connecticut | 1 | New York | 4 |
| Florida | 2 | Ohio | 7 |
| Georgia | 2 | Oklahoma | 3 |
| Illinois | 5 | Pennsylvania | 3 |
| Indiana | 2 | Tennessee | 112 |
| Kentucky | 9 | Texas | 2 |
| Missouri | 1 | Virginia | 5 |
| North Carolina | 4 | Wisconsin | 1 |

c. Cost Breakdown

The estimate of $141,000 (Net) included in the initial budget submission for FY 1954 provided for the operation of the Museum at Oak Ridge, the first full year of operation of two circulating exhibits of the tractor-trailer type, and the outfitting of a third unit for off-area showings. The estimated net cost was reduced to $120,000 in subsequent Commission budget reviews, and as a result plans for the third circulating exhibit were given up and other operating economies are being effected. A moderate increase in FY 1954 estimated gross cost over FY 1953, due to the first full year of operation of the two circulating exhibits, is more than offset by the additional income estimated to be realized from this source and from increased attendance at the

Museum. A detailed breakdown of the actual FY 1953 cost experience and of the current FY 1954 estimate for the Museum program follows:

| | Actual FY 1953 | Estimate FY 1954 |
|---|---|---|
| Personal Services | $ 69,589 | $ 71,000 |
| Travel | 6,428 | 8,000 |
| Transportation and Communication | 2,977 | 4,000 |
| Materials and Supplies | 8,370 | 11,000 |
| Utilities | 4,241 | 5,000 |
| Shop Work and Maintenance | 41,309 | 40,000 |
| Insurance, Advertising and Other Services | 5,259 | 5,000 |
| Institute Distributed Expense | 38,993 | 43,000 |
| | $177,166 | $187,000 |
| Income from Museum | $ 25,994 | $ 30,000 |
| Income from Circulating Exhibits | 23,298 | 37,000 |
| | $ 49,292 | $ 67,000 |
| Net Operating Expense | $127,874 | $120,000 |

d. Attendance at Traveling Exhibits, Calendar Year 1953

| | |
|---|---|
| **National University Extension Association** | |
| Louisiana | 37,000 |
| Texas | 70,000 |
| New Hampshire | 7,000 |
| Maine | 3,850 |
| New York | 6,500 |
| Maryland | 20,057 |
| Total | 144,407 |
| **Fair and Exposition Showings** | |
| Riverview Amusement Park, Chicago | 331,000 |
| Illinois State Fair, Springfield | 250,000 |
| Portsmouth and Chillicothe, Ohio | 14,700 |
| Oklahoma State Fair, Oklahoma City | 238,330 |
| Ohio State Fair, Columbus | 200,000 |
| Arkansas Livestock Exposition, Little Rock | 125,000 |
| Kingsport Industrial Fair, Kingsport, Tenn. | 40,000 |
| Monroe (Michigan) County Fair, Monroe | 50,000 |
| Total | 1,249,030 |
| Grand total for C. Y. 1953 | 1,393,437 |

Source: Research and Medicine Division.

## Objectives

1. Study and evaluation of hazards which may result to humans from exposure to radioactive materials including possible agents of radiological warfare.

2. Study of deposition of radioactive materials in bones. (This is important since one of the main radiation hazards is the ability of the material to deposit within the bone and continuously radiate the blood-forming tissues.)

3. Determine the effect on humans of eating animals which have been exposed to radioactivity or ingested radioactive substances.

4. Determine effect of radiation on plant growth.

## Specific Research Projects

1. Study of distribution and retention in animals of radioactive materials which have been ingested. The length of time and the location of radioactive material in the animal tissues is related to its hazard in consumption.

2. Study of skeletal metabolism and mineral nutrition in large animals, especially the role of calcium. These studies serve as a basis for understanding the factors effecting the deposition and removal from the skeleton of the bone-seeking radioactive materials.

3. Effects of radiation on reproduction and sterility.

4. Evaluation of the effectiveness of various possible sources of radiological warfare through studying the responses of large animals during and following exposure to external radiation.

5. Study of some of the mechanisms of milk secretion with special reference to the method by which calcium and phosphorous are transferred from blood to milk.

## Findings to Date

1. Quantitative patterns have been established for the deposition and removal from body tissues of certain hazardous fission products and bone-seeking radioisotopes.

2. Indications are available as to the amount of exposure to certain radioactive elements which are required to produce bone disorders after a one to two year period.

Findings to Date - Contd.

3. Detailed data are available on the effects of age on calcium metabolism.

4. Blood volumes have been determined for a number of large mammals.

5. Some effects of fluorine on bone metabolism have been clarified.

6. The amount of radiation exposure of a male rabbit which will produce fetal mortality in its offspring has been established.

7. Some information has been gathered on the factors which effect the transfer of calcium and phosphorous from blood to milk.

8. Information is at hand on the amounts of gamma-irradiation effective over different time periods in producing radiation sickness or death in the large mammal.

9. Information has been accumulated on the pathology of acute radiation sickness in the domestic animal.

December 1953

# Capsule Summary of Isotopes Distribution Program

Production and distribution of radioactive isotopes, by-products of nuclear reactor operation, is a major accomplishment in AEC efforts to develop peacetime uses of atomic energy. Program began in 1946.

## 1. Administration of Program

Isotopes Division assigned conduct of AEC-wide program. Dual responsibility includes control and promotion of distribution as follows:

Control

Administer licensing, inspect user facilities, promulgate regulations

Promotion

Coordinate production, encourage industrial participation, information and education activities

AEC expenditures have remained nearly constant during past 3 years even though program has continued to expand (Isotopes Division employees - 50; payroll costs, FY 1953 - $275,152).

## 2. Growth of Program

Demand for isotopic materials continuing. Increase shown by number of applications received in spite of continuous effort to reduce application procedures (general authorizations, exempt quantities, etc.).

| | Applications Received | | | |
|---|---|---|---|---|
| | Radioactive | Stable | Foreign | Total |
| FY 1951 | 3931 | 776 | 201 | 4908 |
| FY 1952 | 4722 | 774 | 276 | 5772 |
| FY 1953 | 5743 | 840 | 375 | 6958 |

## 3. Radioisotope Production

Present

AEC production centered at ORNL. Limited assistance by BNL and in future by ANL and MTR. ORNL production program budgeted at zero. Prices set to meet out-of-pocket costs (not including amortization of facilities). Note: 40% increase in shipments in 2 years without increase in production costs.

| | Shipments | Cost | Revenue | Net |
|---|---|---|---|---|
| FY 1951 | 6896 | $1,061,007 | $1,025,406 | $ 35,601 (loss) |
| FY 1952 | 8809 | 1,004,857 | 1,286,178 | 281,321 (gain) |
| FY 1953 | 9879 | 1,012,089 | 1,117,564 | 105,475 (gain) |

Future

a. Stanford Research Institute recommends in pricing policy survey that prices continue to be based on out-of-pocket costs which will include research and development costs and amortization of new facilities. Prices to include amortization of existing facilities and sunken costs do not appear justified.

b. New research reactor (RR) at ORNL, FY 1955 budget, would be valuable to over-all isotopes production program. Now use extra neutrons at BNL and ANL for local distribution of short-lived isotopes and MTR for production of long-lived isotopes. Need RR in Oak Ridge to make higher specific activities routinely available. Higher flux (1-5 x $10^{13}$ n/cm$^2$/sec) would make RR competitive with Chalk River reactor. Existing processing facilities and trained personnel at ORNL could utilize new reactor to greatest possible advantage.

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c. Fission product pilot plant also included in FY 1955 budget. Plant with capacity for processing 200,000 curies Cs 137 per year would cost $1,500,000; estimated annual operating costs, $200,000. Plant would (1) meet initial needs outlined in Stanford report, "Industrial Uses of Radioactive Fission Products", (2) develop data for design and operation of larger industrial plant for processing megacurie quantities, and (3) meet immediate AEC and military demands. ORNL estimates first year market of 20,000 curies of Cs 137 for industry and military. Reasonable price of $10 per curie would recover operating costs. Plant in no way conflicts with proposed AEC policy of eventually turning over this type of activity to private enterprise.

4. Commercial Participation

Present

Private industry's participation in distribution phases of program continually expanding. Areas of activity include:

a. Processing and secondary distribution of special radiomaterials, compounds, and sources. Yearly business expected to exceed $600,000 in 1953, $1,000,000 within 3 years.

b. Manufacture and sale of instrumentation and equipment. Over 50 firms in business. Annual sales to isotope customers estimated over $5,000,000.

c. Industrial control devices and consultation services. Small now ($250,000 per year) but growing rapidly.

Future

AEC has publicly stated its interests in turning over to private industry an increasing portion of the isotopes distribution program commensurate with public health and national interests. Areas of future commercial participation may be differentiated as follows:

a. Ownership and use of reactors to irradiate materials. These would be stable isotopes irradiated to radioactive forms, target materials supplied by the applicant, or uranium fuel slugs. Recent reports by Tracerlab, Bendix Aviation, and Stanford Research Institute indicate that it is not now feasible nor will it be during the next five years for private industry to finance and operate a high flux reactor for radioisotope production only.

b. Preparation of chemically processed radioisotopes from target materials or uranium slugs (separated fission products). Ownership or control of reactor not necessary. Processing at site removed from reactor. For immediate future ORNL should process bulk sales items of C 14, P 32, and I 131.

c. Extraction of large amounts of waste fission products from plutonium production reactors. Preliminary separation or concentration of wastes would have to be at reactor site or close by. Wastes could be separated as simple mixtures or as individual radioisotopes. Materials could be shipped to user or to commercial firm for further processing and refinement. Commercial feasibility can be determined from AEC operation of pilot plant noted above.

5. International Distribution

Export of AEC-produced radioisotopes has remained nearly constant during past 3 years (increase in FY 1953 largely due to breakdown of Chalk River reactor). To make program comparable with those of Canada, Great Britain, France, and Norway, AEC should (1) modify reporting requirements and (2) include stable isotopes in list of available materials.

6. Radioisotope Utilization

Geographical Distribution

Radioisotopes have been used in all 48 states, D. C., 4 territories, and 37 foreign countries.

Number and Type

Institutions in U. S. which had received authorizations to use AEC-supplied radioisotopes thru October 31, 1953 include:

| | |
|---|---|
| industrial firms | 759 |
| hospitals and private physicians | 613 |
| colleges and universities | 198 |
| federal and state laboratories | 197 |
| foundations and institutes | 41 |
| other | 13 |
| total | 1821 |

Scope

Radioisotopes, sometimes used as sources of radiation but more often as tracer atoms, have found application in:

a. Basic scientific research - hundreds of research teams working on problems ranging from the structure of nuclei to the mechanism of photosynthesis. Over 2800 papers published to date.

b. Medicine

(1) Therapy - over 7,500 patients treated with radioiodine for thyroid disorders; over 5,000 with other isotopes for cancer, polycythemia, leukemia, lesions of the eye and skin, etc.

(2) Diagnosis - over 20,000 thyroid patients; over 5,000 for other tests and clinical procedures.

(3) Research - more groups working on clinical research than any other type of investigation. Over 1500 papers published to date.

c. Agriculture - USDA cooperating with about 30 state experiment stations on fertilizer studies. Some 100 other institutions conducting other studies on plant physiology and animal husbandry. 200 published papers.

d. Industry - approximately 300 firms doing radiographic testing. Some 250 firms using radioactive thickness gages. Others studying wear, detergency, gasoline production, etc.

7. Future Scope and Planning

AEC should continue to:

a. Coordinate isotope production and distribution from all AEC reactors to insure uniform policy and control, to provide assurance that all needs for radioisotopes will be met, and to establish prices to meet out-of-pocket costs.

b. Work with private enterprise in expanding competitive services in areas of the isotope field outside reactor operation.

c. Provide objective controls by publication of regulations and by maintenance of a well organized but small inspection service.

d. Conduct promotional and educational activities with a view toward gradually turning them over to established educational institutions and information media.

e. Work toward a centralized licensing organization which will incorporate all AEC licensing functions into one central office.

c. Physics

Studies are being conducted on nuclear decay schemes and properties, new nuclear reactions and on radioisotopes as a standard of length.

4. Industry

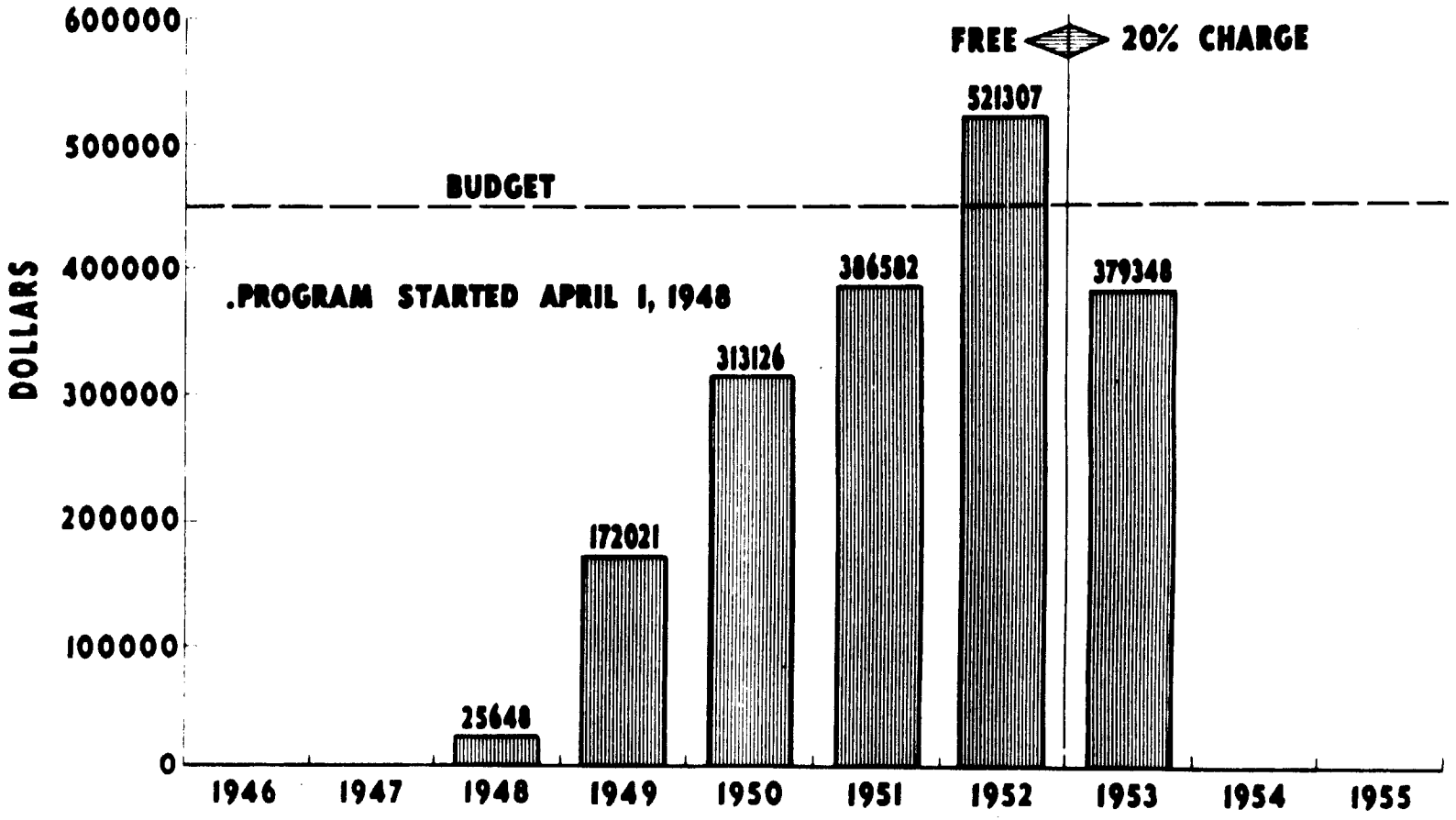
As in medicine, the industrial applications of radioisotopes are of two types -- as tracers and as a source of radiation.

Isotopes are used as a fixed source to measure changes in radiation intensity. The liquid level gage, density meter, thickness gage and radiography process are outgrowths of measurements of transmitted or reflected radiation.

Radiomaterials can also be used to locate or follow a marked object, as liquid flowing through a pipeline; to measure physical transfers or chemical transfers and to trace reactions in other chemical processes, as in the catalytic reduction of petroleum.

Source: Growth in Peacetime Uses of Atomic Energy, By P. C. Aebersold.

# AEC CANCER PROGRAM
## BY FISCAL YEAR (1946-1955)

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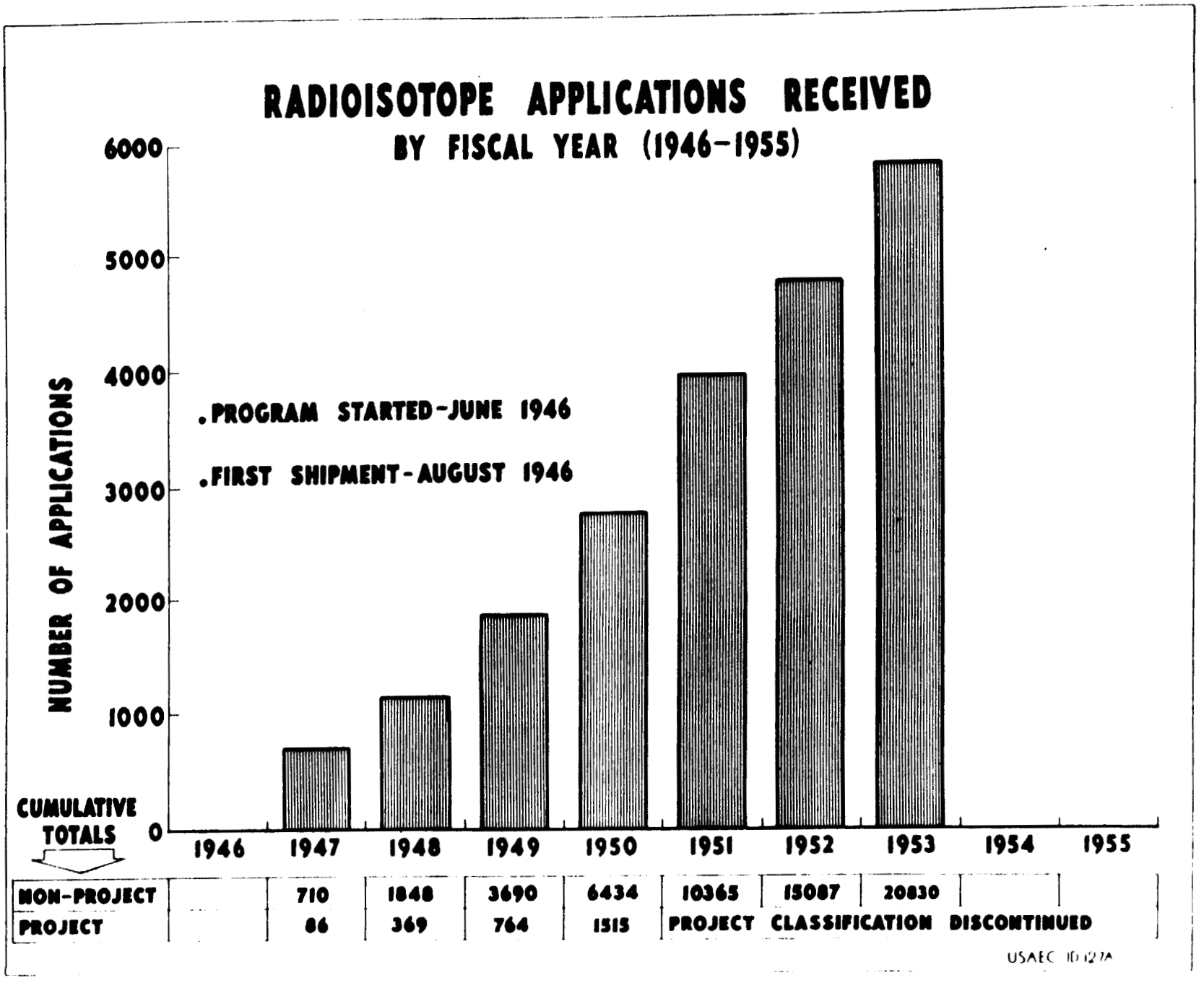
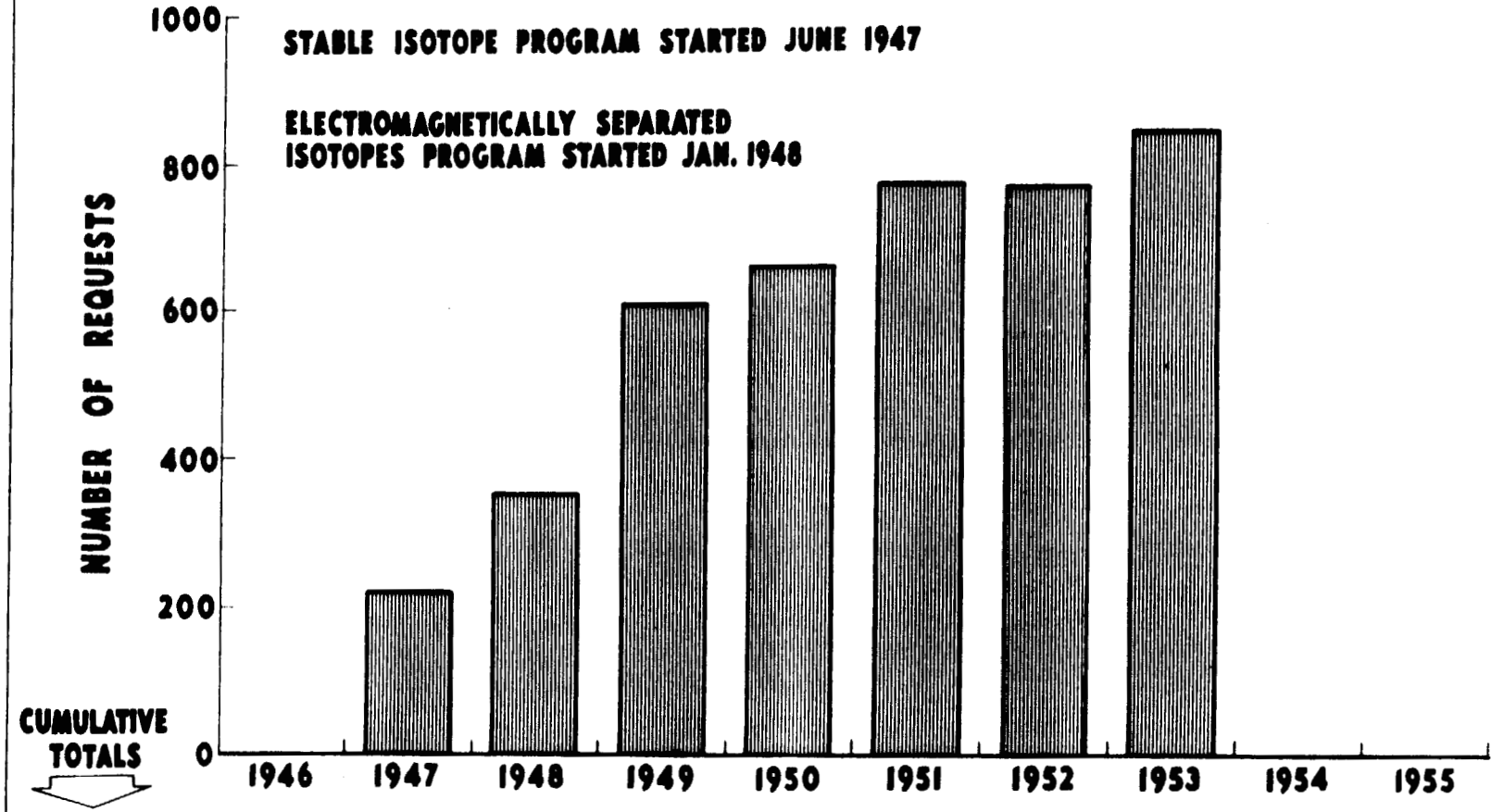

RADIOISOTOPE APPLICATIONS RECEIVED
BY FISCAL YEAR (1946-1955)
NUMBER OF APPLICATIONS
6000
5000
4000
3000
2000
1000
0
.PROGRAM STARTED-JUNE 1946
.FIRST SHIPMENT-AUGUST 1946
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
CUMULATIVE TOTALS
NON-PROJECT
PROJECT
710
86
1848
369
3690
764
6434
1515
10365
15087
20830
PROJECT CLASSIFICATION DISCONTINUED
USAEC ID 127A

# STABLE ISOTOPE REQUESTS RECEIVED
## BY FISCAL YEAR (1946-1955)

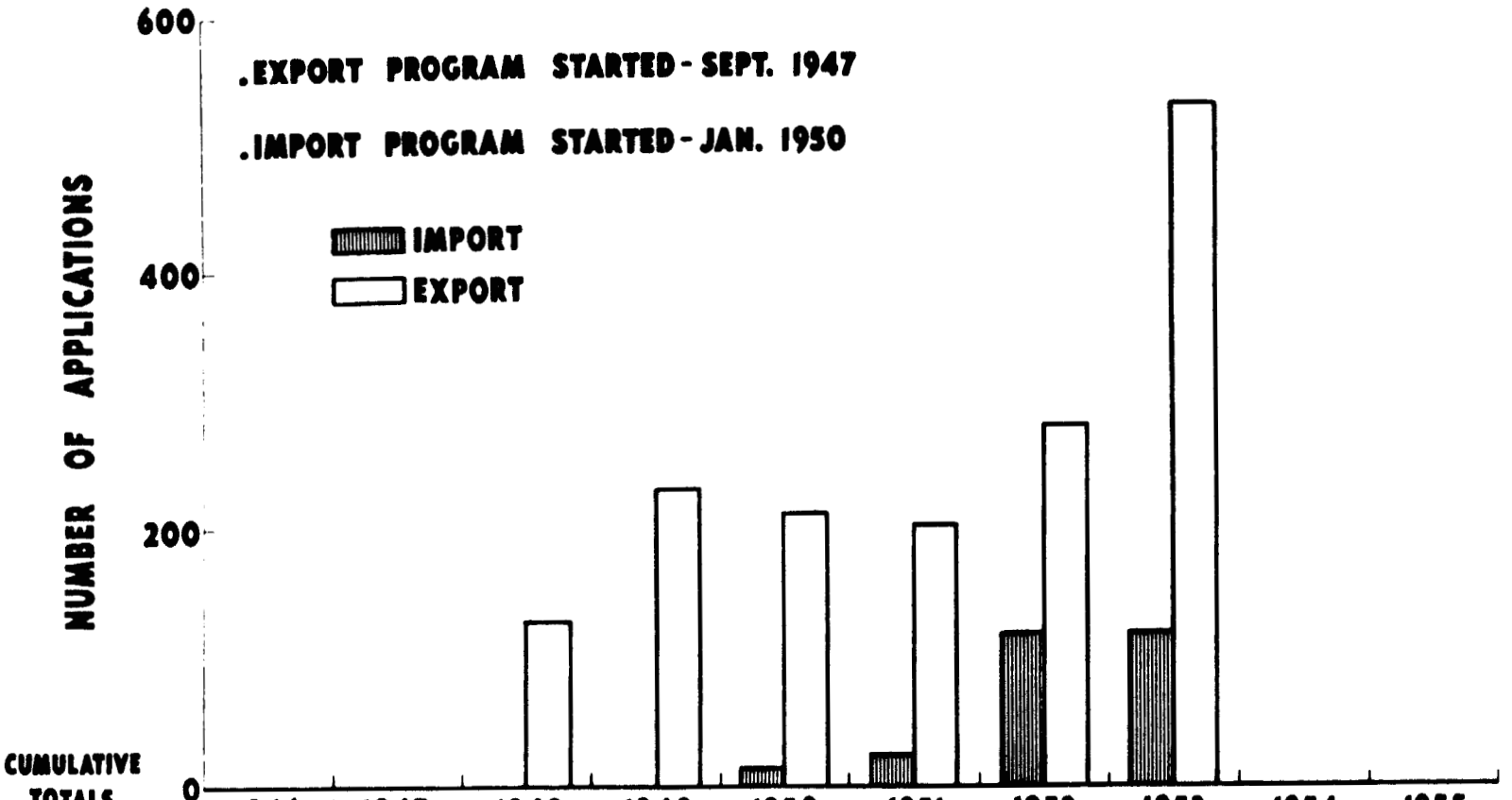



CUMULATIVE TOTALS

| | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 |
|---|---|---|---|---|---|---|---|---|---|---|
| NON-PROJECT | | 87 | 337 | 779 | 1260 | 2036 | 2810 | 3650 | | |
| PROJECT | | 134 | 229 | 397 | 588 | PROJECT CLASSIFICATION DISCONTINUED | | | | |

USAEC-ID 125A

# FOREIGN APPLICATIONS RECEIVED
## BY FISCAL YEAR (1946-1955)




| CUMULATIVE TOTALS | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 |
|---|---|---|---|---|---|---|---|---|---|---|
| IMPORT | | | 0 | 9 | 14 | 37 | 152 | 268 | | |
| EXPORT | | | 125 | 353 | 563 | 764 | 1040 | 1565 | | |

USAEC-ID 123A