13-14

716915

HIGHLIGHTS OF ACTIVITIES OF THE DIVISION OF ISOTOPES DEVELOPMENT FOR 1963

Division of Isotopes Development
U. S. Atomic Energy Commission
Washington 25, D. C.

March, 1964

HIGHLIGHTS OF ACTIVITIES OF THE DIVISION OF ISOTOPES DEVELOPMENT FOR 1963

The AEC's isotopes development program is directed toward (a) encouraging development of beneficial applications of radioisotopes and radiation technology, particularly those designed to meet problems of urgent public interest; (b) accelerating the potential contribution of radioisotopes and radiation applications to the national economy and welfare, and (c) contributing to world development in the peaceful uses of atomic energy. The program is administered by the Division of Isotopes Development. Work is principally carried out at Oak Ridge National Laboratory, Oak Ridge, Tenn.; Hanford Works, Richland, Wash.; Brookhaven National Laboratory, Long Island, N.Y.; Mound Laboratory, Miamisburg, Ohio; and the Savannah River Plant, Aiken, S.C., as well as private research and development laboratories and universities. The isotopes used in the program are produced under the production programs at Hanford and Savannah River, and at Oak Ridge.

Program Phases

The program objectives are being achieved through a multiphase research and development program including the following major elements:

(1) Radioisotope Production and Separations Technology, directed to insuring availability of radioisotopes to meet the changing needs of advancing science and technology in the United States.

(2) Isotopic Fuels Development, aimed at the development and production of isotopic fuels and fuel forms for a broad spectrum of thermal

PAGE 2

OF DOCUMENT 71690

WAS NOT PROVIDED

1106310-A

Table 1.

RADIOISOTOPE SALES FROM OAK RIDGE NATIONAL LABORATORY

(January-December 1963)

Type of sales	Aug. 2, 1946-Dec. 31, 1962	Jan. 1-Nov. 30, 1963	Total to Nov. 30, 1963
Domestic	$15,749,231	$1,185,462	$16,934,693
Foreign	2,337,724	239,013	2,576,737
Total commercial sales	18,086,955	1,424,475	19,511,430
Project transfers	2,528,531	169,684	2,698,215
Medical subsidy 1/	3,683,549	----	3,683,549
Technical cooperation program, local sales to ORNL, Civilian defense	1,028,431	152,571	1,181,002
Special sales 2/	1,342,039	----	1,342,039
Subtotal	8,582,550	322,255	8,904,805
Total	$26,669,505	$1,746,730	$28,416,235

1/ Medical subsidy terminated June 30, 1961.

2/ Special sales category added July 1, 1961, mainly SNAP sources.

Note: This table does not include sales by private commercial firms who act as secondary suppliers, other AEC facilities such as Mound Laboratory and Brookhaven National Laboratory, private firms and universities who own reactors, nor imports into the United States from other countries.

PAGE 4

OF DOCUMENT 716915

WAS NOT PROVIDED

1106311-A

Laboratory (ORNL), in a total of 11,615 shipments with an associated gross income of $1.75 million. This represents a decrease of 3 percent in shipments and a decrease of 38 percent in gross income over the same 1962 period. The total distribution of processed radioisotopes by all AEC facilities during the 17 years of the AEC's radioisotopes distribution program is estimated to be approximately 4.7 million curies. The 1963 decreases are the result of increased sources of supply by non-AEC sources, mainly imports, and no strontium 90 sources for SNAP units being fabricated at ORNL during FY 1963.

The AEC withdrew from routine production and distribution of iodine 131 and iodine 125, effective October 1, 1963. Both radioisotopes are being produced commercially in quantities sufficient to meet ordinary demands, primarily in the medical field.

The Commission's Oak Ridge National Laboratory will continue to supply its unique high-specific activity fission product-produced iodine 131 to meet special research and other needs until such time as an equivalent product is available commercially. The price of this material will be continuously adjusted to recover full production costs or to the lowest cost of commercially supplied iodine 131, whichever is higher. The AEC, as a part of its broader Isotopes Development Program, will also continue its research leading toward a large-scale production technology of iodine 125, which would then be made available to industry.

Cobalt 60 Price Reduction

Effective September 10, 1963, the AEC's price schedules for cobalt 60 were changed by adopting the lowest published commercial prices. To

PAGE 6

OF DOCUMENT 716915

WAS NOT PROVIDED

110G312-A

New Catalog Available

Earlier in the year, a new completely revised Radio and Stable Isotopes Catalog was published by the Isotopes Development Center at Oak Ridge National Laboratory, the principal supplier of isotopes under the Commission's programs. The new catalog, available from the Center, lists the many price adjustments and sales procedures that have been implemented since the last printing in May 1960.

Radioisotope Production Technology

The major effort of the Commission's isotope production development program during the past year has been directed to advanced fuel forms for isotopic power applications. Radioisotopes under consideration for use as heat sources[1/] include the fission products: strontium 90, cesium 137, cerium 144, and promethium 147; and the products obtained by neutron irradiation of special target materials: plutonium 238, polonium 210, curium 242, curium 244, and cobalt 60.

Thermal and Radiation Applications

The AEC is cooperating with the U. S. Air Force in an investigation of the use of radioisotopes to operate rockets. Space Technology Laboratories (STL), Redondo Beach, Calif., is performing a detailed study, under AEC contract, of the role isotopes can play in space missions other than that of providing auxiliary electrical power.

1/ The heat generated by the decaying radioisotopes is converted into useful electricity through thermoelectric couples, thermionic diodes, or rotating equipment.

PAGE 8

OF DOCUMENT 71615

WAS NOT PROVIDED

1106313-A

petition to FDA for clearance of selected radiation-processed citrus products. Other petitions currently under preparation jointly by the AEC and the Department of Army are for clearance for carrots at both the sprout control and sterilized levels, and for peaches and nectarines.

The U. S. Army Radiation Laboratory, Natick, Mass., was placed in operational use in 1963 for studies on radiation sterilization of food products important to the military establishment. The facility was designed and constructed by the AEC for the Department of Army. The Laboratory contains the world's largest cobalt 60 radiation source of approximately 1.3 million curies, a high energy 24 Mev, 18 kw linear accelerator, and a complete food preparation area.

The Commission's research program on radiation pasteurization of foods is to develop the technology for providing fresh-like fish and fruits far from harvest areas to open up new markets for these products. Relatively low radiation doses (less than 500,000 rads) are being used with perishable foods to inhibit bacterial growth for periods of time ranging from days up to several weeks under normal refrigerated distribution and storage conditions. This low dose radiation pasteurization of foods program is complementary to the radiation sterilization of foods program of the U. S. Department of Army where high doses (up to 4.5 megarads) of radiation are used to completely destroy bacteria and permit food storage without refrigeration for months. The foodstuffs, themselves do not become radioactive during the processing.

The AEC research and development program is limited to selected fruit and fisheries products and emphasizes factors such as storage and shelf-

PAGE 10

OF DOCUMENT 71695

WAS NOT PROVIDED

110314-A

University it has been determined that freshly caught shrimp are especially amenable to radiation pasteurization. Doses of 50,000 to 100,000 rad can increase this storage time to about 30 days and will also control melanosis or "black spot" discoloration in shrimp.

Fruit and Vegetable Products

Large scale irradiation of fruit was conducted in 1963, under field conditions, with a mobile cobalt 60 truck irradiator. Subsequent shipping and storage tests were carried out to evaluate economic aspects.

A marketing study, recently conducted by the U. S. Department of Agriculture (USDA), indicates that the cost for the radiation treatment of fruit will be justified by the increased keeping quality and storage life of the product.

At the University of Florida, Gainesville, work is proceeding on the irradiation of tomatoes and citrus products. Michigan State University, Lansing, has initiated work on Midwestern fruit products, including cherries. At the University of California's Davis Campus, preservation of strawberries and sweet cherries with dose levels of 200,000 to 250,000 rads has proved very promising.

Wholesomeness and Public Health Safety

A detailed outline of necessary work, or "protocol," for the conduct of long term, chronic toxicity animal feeding studies to determine the wholesomeness of low-dose irradiated foods was developed and has received formal approval from the Food and Drug Administration (FDA). Two-year feeding studies on irradiated soft-shell clams and short-term studies for biological evaluations of protein utilization from irradiated haddock, flounder, crab, and soft-shell clams have been initiated.

PAGE 12

OF DOCUMENT 71690

WAS NOT PROVIDED

1106316-A

from the irradiated material when in contact with the food product. Results, so far, are favorable, and clearance of these packaging materials for use with radiation-processed foods has been requested from FDA.

Acceptability

The reaction of the consumer to radiation-processed foods is being determined both in laboratory and in large-scale field tests. Several laboratory evaluations have been completed. The first large-scale consumption of low-dose radiation-processed food took place at Fort Lee, Va., in late 1963, when volunteer Army troops were fed radiation pasteurized haddock as part of their regular ration. This, and other AEC-developed products, are being included by the Department of Army in a series of large-scale acceptability tests involving both pasteurized and sterilized products.

Irradiators

Marine products irradiator. The construction of the Marine Products Development Irradiator at Gloucester, Mass., will be completed in mid-1964. The $600,000 facility will operate on a near-commercial scale, processing marine products at a rate up to one ton per hour using a 250,000-curie cobalt 60 source. The irradiator is to be operated as part of the research and development program conducted for the Commission by the Technological Laboratory of the Bureau of Commercial Fisheries, U. S. Department of the Interior.

On-ship irradiator. A conceptual design study for an on-ship fish irradiator has been completed for the AEC by Vitro Engineering Corp., New York City. Such an irradiator would permit irradiation of marine

PAGE 14

OF DOCUMENT 7 1/2 9 10

WAS NOT PROVIDED

11663 16A

During 1963, Esso Research and Engineering Co. announced development of a radiation process for the production of bio-degradable detergents. Previously, the first industrial use of radiation for bulk chemical manufacture in the United States had been announced in 1962 by the Dow Chemical Company for commercial production of ethyl bromide, a low-volume but industrially-important chemical, using cobalt 60 as the source of radiation energy.

Listed in the tables are radiation processed products now being manufactured in the United States and those which appear to have commercial potential in the reasonably near future. It is estimated that 50 kilowatts of installed radiation power, involving both isotopic and machine sources, are now in use for commercial radiation purposes. Trade sources place the process radiation business at about 20 million dollars a year.

Current commercial processes, while still relatively limited in number and dollar value, nevertheless have shown that continued research and development on process radiation by both Government and industry will broaden the range of productive radiation applications and thus contribute to the national economy and welfare. The AEC's process radiation development program recognizes the appropriate limits to AEC-sponsored research on radiation processing and the beginning of private industry's commercial responsibilities. Thus, it is not directed primarily toward specific product development, but rather to provide a foundation of radiation technology, not otherwise available, which is of general applicability and basic to the commercial development by private industry.

PAGE 16

OF DOCUMENT 7169RS

WAS NOT PROVIDED

110C317-A

Table 4.

NEAR-FUTURE COMMERCIAL RADIATION PROCESSES [1/]

Process	Probable Radiation Source	Potential Use
Radiation curing of coatings	Machine	Plastic-coated plywood panels, paint primer curing.
Textiles	Machine	Dyeability, mildew resistance, fire retardation, water resistance.
Wood-plastic alloys	{Machine / Cobalt 60}	Wood construction, furniture, piling, sporting equipment.
Sterilization of medical supplies	Cobalt 60	Bulk packaged sutures, catheter kits, etc.
Food pasteurization	Cobalt 60	Extension of shelf life (fish and fruit).
Semiconductor devices	n-γ flux [2/]	Transistors, diodes, multifunctional devices.
Food sterilization	Cobalt 60	Military rations (chicken, beef, pork, and ham).
Enzyme sterilization	Machine	Pharmaceuticals and food.

1/ Source: Chemical and Engineering News (April 22, 1963) published by American Chemical Society, Washington, D. C.

2/ Neutron-gamma flux from nuclear reactor.

PAGE 18

OF DOCUMENT 71695

WAS NOT PROVIDED

110C318-A

and located at Brookhaven National Laboratory, is intended to provide data leading to a Radiation Engineering Handbook. The handbook will contain information on basic radiation physics, source design and fabrication, computational procedures, safety aspects, health physics, shielding calculations, and economic guidance. Thus, it will provide all the information essential for the engineering design and the construction of both pilot plant and commercial radiation facilities. A preliminary edition is scheduled to be published during 1964.

Process Applications

The process radiation program encompasses a wide, coordinated spectrum of effort, as represented by 23 offsite contracts plus major work at Brookhaven National Laboratory. Several key radiation processes have shown important advances during the past year. Three such processes have reached the point in development where their technical feasibility has been demonstrated, and they are nearly ready for engineering scale-up testing.

Wood-plastic combinations. Research was continued during the past year at West Virginia University, Morgantown, to further improve the process of producing wood-plastic combinations using radiation. These materials were produced by impregnating various woods with chemical monomers and then treating them with radiation. A great number of wood-plastic combinations with wide ranges of valuable properties have been produced. Five hundred samples have been prepared at Brookhaven and are being distributed to interested industrial groups for evaluation. Areas of application for this wood "alloy" appearing to hold promise include:

PAGE 20

OF DOCUMENT 7169

WAS NOT PROVIDED

1106319-A

(c) low-level tracer process control, (d) radiation absorptiometry, (e) ionization technology (static elimination, luminescence, etc.), (f) nondestructive testing, (g) isotope measurement systems, and (h) safety testing.

Neutron Activation Analysis

AEC-sponsored research and development is accelerating the rate and scope for use of neutron activation analysis in American industry and technology, and is providing increased public benefits in problems important to the national economy.

In activation analysis, a sample of an unknown material is first irradiated (activated) with nuclear particles. The irradiated atoms are usually made radioactive by absorption of slow neutrons. Since the atoms disintegrate with the emission of high-energy gamma rays, the rays are analyzed for their characteristic energy and intensity. These nuclear "fingerprints" can then be located on data tables to identify the artificially created nuclei and, by inference, also the elements in the original nonradioactive material.

Automatic coal analysis. The analysis of coal by neutron techniques for carbon, aluminum, oxygen, and silicon content has been successfully demonstrated on a laboratory basis. From the data, the heat content, or BTU (British thermal unit), of coal can be derived (under conditions of relatively constant water content in the coal) using a specialized computer developed for the purpose. This technique is the first step toward continuous analysis of coal at the mine site, an objective which is being pursued under AEC contract with Texas Nuclear Corp., Austin, Tex. Because

PAGE 22

OF DOCUMENT 71695

WAS NOT PROVIDED

1106320-A

These crime detection methods are being brought into almost immediate use as they are developed. In San Diego, the activation analysis technique helped to identify a murder suspect who subsequently confessed; in Los Angeles, it helped to clear a murder suspect; and in Washington State, nuclear comparison of hair samples indicated that a suspect was not guilty. Police departments throughout the country have shown considerable interest in this work.

APPLICATIONS TO NATURAL RESOURCES

Mineral Beneficiation

The application of nuclear techniques to the processing of minerals other than coal is continuing at the Colorado School of Mines, Golden, Colo. A technique has been developed for the continuous measurement and control of potash concentration by following the potassium 40 increase as the mineral is concentrated into its pure form.

Sediment Measurement in Streams

A gage for the continuous measurement of the concentration of sediment in streams is under development at Parametrics Corp., Waltham, Mass. The unit uses cadmium 109 which emits a soft X-ray. The attenuation of the X-ray is proportionate to the concentration of sediment in the flowing water. The continuously recorded output is intended to make possible the first continuous record of fluctuations in stream sediment burden - information of considerable importance to hydrologists. This has major implications in agriculture, reclamation, navigational development, and prediction of the fate of radioactive waste.

In laboratory tests, the device has demonstrated a capability for measuring sediment concentrations down to 0.1 percent. This represents

PAGE 24

OF DOCUMENT 716915

WAS NOT PROVIDED

110632I-A

through washing, peeling, blanching, and other such operations in food processing. Radioisotope techniques have shown that more water than necessary is often used in washing procedures. In relatively dry farming areas, proper water management and conservation is a very important factor.

The goals of this project are to develop improved food cleansing techniques and to acquaint the canning industry with radioisotope procedures which will measure the efficiency of their food washing processes.

Radiometric Analysis

Several new radiometric analytical methods were developed during 1963 in projects at Oak Ridge National Laboratory. One such method is for determination of fluoride ions. The method operates by releasing tantalum 182 from a column of tantalum metal. The activity of the released tantalum is proportional to the concentration of fluoride in the sample solution. The method is considered more rapid and accurate than the conventional method for analysis in the milligram range. The method is particularly useful for measuring fluoride in rocks and minerals.

Preventing Aircraft Bombings

A few years ago, after a series of fatal airline crashes were linked to deliberate bombings, the Federal Aviation Agency (FAA) and the Senate Subcommittee on Aviation requested the AEC to develop nuclear techniques for detecting hidden explosives being smuggled aboard flights. In 1962, an experimental device employing a stable (activation) tracer was successfully demonstrated. However, available activation and detection equipment proved too expensive and the effort was then directed to development of a technique employing the use of a very small quantity of

PAGE 26

OF DOCUMENT 71615

WAS NOT PROVIDED

1106322-A

computer logic which allows it to integrate the count rate and automatically print out the rate and direction of current drift. The deep-water version has a specially developed compass that accurately indicates the orientation at all times.

Increasing Oil Production

Recent studies conducted in a joint AEC-Bureau of Mines program have shown that radioisotopes can play an important role in evaluating the efficiency of oil well flooding operations. Many "spent" oil fields can be brought back into production by proper water flooding. One of the major problems encountered in water flooding is lack of homogeneity in underground rock structure. These distortions permit flow patterns between the various wells which often causes the water to by-pass the oil in the less permeable portions of the reservoir. To correct for these heterogeneities, their presence and extent must be determined. If water containing tritium or krypton 85 as a tracer is employed to flood the oil reservoir, the flow pattern of the water can be followed by analysis of water samples taken from other wells.