PACIFIC NORTHWEST LABORATORY
MONTHLY REPORT TO THE
DIVISION OF ISOTOPES DEVELOPMENT
FOR August 1970

Edited by J. E. Hansen

September 15, 1970

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FOR AUGUST 1970

08-01. RADIOISOTOPES PRODUCTION AND
MATERIALS DEVELOPMENT

08-01-03. FISSION PRODUCTS

I. LOW COST CESIUM AND STRONTIUM SOURCES

Nothing to report.

II. RADIATION CHARACTERISTICS OF FISSION PRODUCT Rh AND Pd -

F. P. Roberts

The traditional view of fission products is that they are waste materials, but some fission products, such as Rh, Pd, Ru, and Tc, have or will have future uses and should be considered for their resource potential. A resource strategy should be developed to determine the optimum technological and economic use of these elements. This study would answer these questions:

- 1. What is the market for Rh, Pd, Ru, and Tc for the next 40 years?*
- 2. What are the radiological hazards for the use of these elements on a benefit-risk basis?*
- 3. Is there justification for a national policy requiring that these elements be set aside as a national resources stock-pile for future use?*
- 4. What would be the impact of an almost irreversible storage of these elements on the economics of recovery if they are needed in the future?*
- 5. Is it economically desirable to perform a gross separation scheme that will separate these elements and store them for 20-50 years so that they will be available for future use?*

A. ^{102m}Rh half-life

^{102m}Rh half-life-work has been temporarily discontinued on the measurements to determine the half-life of ^{102m}Rh because of serious difficulties encountered with the counting instrumentation. These difficulties were brought about by moving the equipment into another laboratory which did not have adequate temperature control. This resulted in the failure of the linear amplifier as well as a marked deterioration of the stability of the whole counting system. Work is now in progress to install air conditioning and a new linear amplifier is being procured.

B. Isotopic Composition of Fission Product Rh

Nothing to report.

III. EVALUATION OF LARGE SCALE USES FOR PURIFIED FISSION PRODUCT XENON

Nothing to report.

IV. ISOTOPE PRODUCTION EVALUATIONS - R. W. McKee

This program is designed to evaluate major aspects of isotope production. Until recently, the principal source of isotopes has been the AEC production reactors. Now, however, power reactors are rapidly becoming important sources of isotopes. Power reactors also offer attractive prospects for target irradiations. The future availability and cost of these unique isotopes depends on full and efficient utilization of the production potential of power reactors, and the inherent value of these materials can have a significant impact on nuclear power costs.

The scope of this program includes analysis of fast and thermal reactor fuel cycles within the framework of an expanding nuclear power industry to identify the sources, quantities, timing and cost of production of isotopes of potential importance.

A new task to develop an Isotope Data System was initiated in FY-1971. The objective is a computerized, quick-response system for answering queries on isotope properties, availability, applications, shielding requirements, decay compositions, toxicity, and other factors.

A. Fission Product Profitability Studies

Approval was received for the revised study plan and preparation of the computer program for carrying out the parametric calculations was commenced. In addition, a design basis for the Cs/Sr recovery facilities was prepared and transmitted to Vitro, Hanford Engineering Services for preparation of construction cost estimates.

B. Isotope Data Compilations

Work continued on updating the "Nuclide Tables" data file.

08-01-04. SOURCE DEVELOPMENT

I. NONDESTRUCTIVE TESTING OF SOURCES -

A. NDT for Irradiation Sources - D. R. Newman

The scope of this program is to develop methods of nondestructive examination of isotopic heat sources developed by DID contractors. Through a number of programs, DID is developing applications for various radioisotopes as heat sources for specific applications. The BNW program will concentrate on the development of methods to assure the long-term mechanical and thermal integrity of the as-manufactured sources.

Because it is important that NDT methods are compatible with capsule design, e.g., welds should be physically accessible for inspection, the approach of this program is to become involved early with contractors who have design and development responsibilities. Continuing liaison will ensure that NDT methods are available for the source under development.

Work this month continued on the reports of our multielement work. BNWL-1491, "Multielement Ultrasonic Transducer Test Techniques," should be finished soon. Summaries were written of the two articles/talks mentioned in last months report.

Preliminary design of the differential transducer was started. This transducer is designed to increase the signal to noise ratio from flaws in a weld or cladding. It should also be able to resolve defects which are very close to the surface of the object in question.

II. TECHNOLOGY PUBLICATIONS - E. J. Wheelwright

The objective of this program is to provide technology for the use of Pm as a radioisotope heat source in aerospace or terrestrial applications. In the past, the program has included development of scientific and engineering data pertinent to: (1) the purification of Pm and conversion to a useful fuel form; (2) the design and fabrication of Pm heat sources and (3) hazards analyses associated with radioisotopic heat sources. Presently, principal emphasis of the program is directed to the dissemination of Pm technology to the technical and scientific community.

The FY-1971 goal is to complete the metal compatibility studies and to make final arrangements for the publication of a book on Pm technology.

Writing on the remaining uncompleted chapters is being vigorously pursued on all but the Analytical Chemistry Chapter, and they should be completed during the second week of September. This does represent a two-week delay in the project schedule. The projected completion date of the analytical chapter will not delay submission of the manuscript, in rough draft form, to DID during October for review.

III. ADVANCED SOURCE DEVELOPMENT - J. H. Jarrett

A. Advanced Alpha-Photon Source Development

The objective of this program is to evaluate present and future heat and radiation source application requirements and to relate them to present and future encapsulation technology.

The goal of the current work is concerned primarily with the development of thin-film encapsulation and evaluation techniques for alpha/photon sources. Emphasis will be directed towards the technique of sputtering as a means to obtain thin films of the radioisotope and the containment materials.

The glovebox sputtering system that was located in Room 324, 325 Building has been moved to Room 504, 325 Building. The glovebox installation was completed in August. Improvements were made on the closed-loop cold water recirculation system that is needed to cool the sputtering target and substrate while the system is in operation. The old black iron heat exchanger was replaced with a stainless steel heat exchanger. A filter was placed in-line between the recirculation pump and the sputtering module. This greatly reduces the amount of suspended matter in the cooling water and minimizes the possibility of plugging flow passages. The glovebox was cleaned extensively, and tool boxes for storing sputtering targets and hand tools were added. These housekeeping steps will make it easier to remove freshly sputtered sources and samples from the glovebox without adding contamination to them.

An experiment to determine the amount of contamination added to a clean sample during sputtering and during sample removal has been planned. Beryllium will be deposited on a mirror finish stainless steel substrate using the glovebox sputtering system. The sample will be removed from the glovebox and counted for radioactive contamination. Positive results from this experiment will help demonstrate the feasibility of preparing radiation sources using different radioisotopes in the glovebox sputtering system without a significant degree of cross-contamination. It will also help demonstrate techniques for removing sources from the system without adding contamination to them.

Continuing efforts are being made to improve the quality of radiation sources prepared by rf-sputtering. New hardware for source preparation has been designed and fabricated. Sources with a 1/2 inch diameter active area and planar ring sources may be prepared using the improved hardware. Type 304 stainless steel substrate material has been procured. The 16 gauge stock has a mirror (7B) finish that should give better adherence between the substrate and subsequent layers deposited by rf-sputtering. Surface irregularities should also be minimized. Ten grams of $^{241}\text{AmO}_2$ were procured from ORNL for the preparation of second generation alpha/photon and photon radiation sources.

08-02. THERMAL APPLICATIONS

08-02-01. CIRCULATORY SUPPORT SYSTEMS - F. T. Cross and J. C. Sheppard

A. Radiation Characteristics - Nonpromethium Systems

The objective of this program is to determine the dose from radioisotopic heat sources suitable for circulatory support systems. This is accomplished by measuring the dose rates within and surrounding various tissue equivalent phantoms.

Part of the program is concerned with the prediction of the measured dose rates by the development or employment of computational codes. The computer codes are also used in parametric studies and for the prediction of the in-phantom dose rates from sources not available for measurement.

1. Shielding and In-Phantom Dose Prediction

Computational techniques are being developed for determining the dose to various organ systems from an implanted ^{238}Pu source located on the inside surface of the left ilium. Preliminary computations using the reciprocity theorem of Mayneord indicate that at the larger source-organ distances, the dose rates are only weakly dependent on the organ geometry. This

is to be expected as the dose rates are varying slowly with distance. The organs will be approximated by combinations of rectangular, cylindrical and spherical shapes as these are the geometries limited to the QAD-code.

2. In-Phantom Dosimetry Measurements

Some measurements of the dose rates from an implanted ^{252}Cf source are being repeated to corroborate or improve some of the earlier measurements.

08-03. RADIOISOTOPE SYSTEMS DEVELOPMENT

08-03-03. OCEANOGRAPHIC AND NATURAL RESOURCE APPLICATIONS

I. MARINE SYSTEMS

A. Nuclear Techniques for Seabed Mineral Exploration - R. W. Perkins and N. A. Wogman

In recent PNL studies of the composition of deep ocean sediments, it has been demonstrated that various mineral deposits and commercial-grade ores can readily be identified by neutron activation and instrumental analysis. From preliminary analysis, it is evident that the elemental composition of most mineral deposits can be easily identified at concentrations well below those of economic importance. In-place experience with Cf-252 as a neutron source has confirmed these conclusions. Two methods for in-place seabed mineral exploration are being investigated. The first involves placing a neutron source and detector system on the ocean floor. The second method involves bringing the samples on-board ship and employs a shipboard Cf-252 irradiator and a Ge(Li) spectrometer. The former technique has the advantage of very rapid analyses, and the latter technique has the advantage that mineral depth-profiles can be defined from core sampling.

A 1.80 mg ^{252}Cf source has been received for continued development of the Seabed Mineral Exploration program. The source characteristics are as follows:

^{249}Cf	<1.4%
^{250}Cf	9.87%
^{251}Cf	2.73%
^{252}Cf	85.25%
^{253}Cf	0.75%
^{254}Cf	0.057% (by neutron counting)

The double encapsulated, stainless steel, screw-top capsule was repackaged in a Battelle-Northwest source assembly and inserted in the irradiation prototype system. This system is constructed from a 6-ft-diameter polyethylene container which is 7 feet tall and located in a 15-ft-diameter by 7-ft-deep swimming pool. This assembly provides maximum shielding of the source, reducing neutron and gamma-ray radiation levels below detectable limits.

Two-hundred pound copper, silver, lead, zinc, molybdenum, manganese, and cadmium ore samples have been obtained for evaluation within this assembly. The irradiation of these ores will provide a calibration standard between the ^{252}Cf source and a Ge(Li) diode. This standardization will yield the necessary information to determine the design criteria of ^{252}Cf size and Ge(Li) detector efficiency for the undersea mineral probe.

An additional 10 mg of ^{252}Cf as five 2 mg sources is expected in late December.

PROMETHIUM INVENTORY - AUGUST 31, 1970

Received from ARHCO		16,361,900 Ci
Transfers and Shipments	1,448,500	
Concentrated Feed	5,524,960	
Product		
Run 22, 465 Ci/g, 8/31/70	19,850	
Run 40, 534 Ci/g, 8/31/70	36,275	
Run 55, 690 Ci/g, 8/31/70	81,645	
Waste	677,320	
Unaccounted	1,363,640	
Decay	7,209,710	
Total	16,361,900	

Production and Transfers

None.

DID BUDGET STATUS - FY-1971 Through August 31, 1970

	<u>Cost</u>	<u>Cost to Date</u>	<u>Budget</u>
08-01 <u>Radioisotope Production and Materials Development</u>			
08-01-03 Fission Products			
I. Low-Cost Cs Sources	3.9	6.8	80
II. Rhodium and Palladium	2.8	6.0	20
III. Xenon	0.3	0.3	20
IV. Evaluation of Isotopes Production	<u>6.2</u>	<u>12.5</u>	<u>80</u>
Subtotal 08-01-03	13.2	25.6	200
08-01-04 <u>Source Development</u>			
I. NDT R&D Support	3.3	4.7	25
II. Technology Publications	2.3	2.8	20
III. Advanced Source Development	<u>7.4</u>	<u>16.4</u>	<u>50</u>
Subtotal 08-01-04	13.0	23.9	95
Subtotal 08-01	26.2	49.5	295
08-02 <u>Thermal Applications Development</u>			
08-02-01 <u>Circulatory Support Systems</u>			
I. Circulatory Support	<u>6.2</u>	<u>13.5</u>	<u>85</u>
Subtotal 08-02	6.2	13.5	85

	<u>Cost</u>	<u>Cost to Date</u>	<u>Budget</u>
08-03 <u>Radioisotope Systems Development</u>			
08-03-03 <u>Oceanographic and Natural Resource Applications</u>			
I. Seabed Mineral Exploration	<u>6.2</u>	<u>12.6</u>	<u>60</u>
Subtotal 08-03	<u>6.2</u>	<u>12.6</u>	<u>60</u>
 Total 08 Operating Budget	 38.6	 75.6	 440
 08 Equipment Budget	 <u>0</u>	 <u>0</u>	 <u>5</u>
 Subtotal 08	 <u>38.6</u>	 <u>75.6</u>	 <u>445</u>
 Pm Inventory Account	 <u>3.8</u>	 <u>9.1</u>	 <u>210</u>
 PROGRAM GRAND TOTAL	 <u>42.4</u>	 <u>84.7</u>	 <u>655</u>