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**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
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HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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BUDGET FOR FY 1967
AND REVISED BUDGET FOR FY 1966
SEPARATIONS RESEARCH AND DEVELOPMENT PROGRAM
(02 50 10 15 1)

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BUDGET FOR FY 1967
AND REVISED BUDGET FOR FY 1966
SEPARATIONS RESEARCH AND DEVELOPMENT PROGRAM
(02 50 10 15 1)

By

R. E. Tomlinson

Research and Engineering
Chemical Processing Department

April 1, 1965

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By Authority of DS Lewis

CG-nmp-1, 5-5-94

By DL Hanson, 5-31-94

Verified By J E Savely 6-16-94

Work performed under Contract #AT(45-1)-1350
between the Atomic Energy Commission and the General Electric Company

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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SCHEDULE 189

Additional Justification for Operating Costs

RICHLAND
OPERATIONS OFFICE

SPECIAL NUCLEAR MATERIALS

PROGRAM

15-1

1. Contractors: General Electric Company		Contract No. AT(45-1)-1350	Task No.
2. Project Title: Separations Processes		189 No.	3. Budget Activity No. 02 50 10 15 1
4. Date Prepared: April 1, 1965	5. Method of Reporting: Annually	6. Working Locations: Hanford 300 and 200 Areas	
7. Person in Charge: R. E. Tomlinson Principal Investigator:		8. Project Term: Continuing From: To:	

9. Man Years:	<u>FY 1965</u>	<u>FY 1966</u> (BNW)	<u>FY 1967</u> (BNW)
(a) Scientific and Technical	23.1	19.2	20.9
(b) Other	11.6	11.0	13.3
Total	<u>34.7</u>	<u>30.2</u>	<u>34.2</u>
10. Costs:	<u>FY 1965</u>	<u>FY 1966</u>	<u>FY 1967</u>
(a) Direct Labor (Including Continuity of Service)	395,000	397,000	398,000
(b) Materials, Technical Services, Subcontracts	465,000	679,000	866,000
Total Direct	<u>860,000</u>	<u>1,036,000 (756,000)</u>	<u>1,264,000 (935,000)</u>
(c) Indirect Expenses	176,000	97,000	129,000
Total Operating Cost	<u>1,036,000</u>	<u>1,133,000</u>	<u>1,393,000</u>
(d) Equipment (Obligation)		121,000 (96,000)	163,000 (103,000)
(e) Irradiation Unit Cost			

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OPERATIONS OFFICE

02 50 10 15 1 - Separations Processes

15-2

Scope

The Separations Research and Development Program consists of five identifiable activities in four general areas of effort. (Waste Management Research and Development Programs, previously included in Separations Research and Development Programs, are separately funded and documented.) The activities and their proposed levels of effort are listed in the following table:

Activity		Manpower and Costs (in thousands of dollars)							
		FY 1965		FY 1966			FY 1967		
		Man Years	Costs	Man Years	Costs	BNW	Man Years	Costs	BNW
<u>Chemical Processes</u>									
(011)	Current Processes	6.5	191.0	3.4	119.0	100.0	3.0	110.0	91.0
(012)	Innovations and New Business	15.1	460.0	19.3	742.0	509.0	23.6	927.0	706.0
(013)	Subtotal for Chemical Processes	21.6	651.0	22.7	861.0	609.0	26.6	1037.0	797.0
<u>Chemical Safety</u>									
(020)				1.0	32.0	18.0	1.5	93.0	20.0
<u>Process Equipment and Control</u>									
(030)	Equipment and Instrument Development	9.0	267.0	4.1	164.0	88.0	4.1	192.0	80.0
<u>By-Products</u>									
(051)	Recovery and Purification	4.1	118.0	2.4	76.0	41.0	2.0	71.0	38.0
	Total, Separations Development	34.7	1036.0	30.2	1133.0	756.0	34.2	1393.0	935.00

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For each activity, the major accomplishments of the last year are listed, together with the proposed goals for the next two years in the following pages. (Waste Management Programs are reported in the 02 50 60 0 0 program document.) Significant trends in the program are noted below.

General

The change in the distribution of funds between 10 b. Materials, Technical Service, Subcontracts, and 10 c. Indirect Expenses reflects changes made in accounting practices as a result of segmentation of Hanford. Indirect Expenses include, as overhead costs, the Chemical Processing Department internal overheads and Pool Assessments. Battelle Northwest costs, including their overhead functions, are treated as a Direct Expense in the Materials, Technical Services, Subcontracts category. The dollars set aside for Battelle Northwest Laboratory (BNW) are lump-sum totals which include funds for management assessments but exclude Pool Assessment charges. The increase in the ratio between 10 a. Direct Labor and 10 b. Materials, Technical Services, Subcontracts (above that caused by the noted change in accounting practices) represents the cost of prototypical equipment for demonstrating technological improvements and for developing special purpose equipment.

Chemical Processes

Continued declining levels of expenditures in the Current Processes Subprograms reflect the declining emphasis on plutonium production. Efforts will be continued to reduce operating costs, improve product quality, improve plant safety, and develop new technology to improve capability for the recovery of by-products such as neptunium and transplutonium isotopes.

Levels of expenditures will continue to increase in the Innovations and New Business Subprogram through FY 1967. Promising low cost processes for producing and separating Po-210 from irradiated bismuth will be pursued vigorously with demonstration of the Po-210 process planned during FY 1966. A low cost closely coupled irradiation-separation process for producing Pu-238 by irradiation of Np-237 will be developed in FY 1966 and demonstrated in FY 1967. Intensive support will be given to the Hanford U-233 program. The

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02 50 10 15 1 - Separations Processes

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Chemical Processes (continued)

potential has been recognized for recovering "ultra-pure" U-233 (i.e., < 1 ppm U-232) during the separation of "clean" U-233 (i.e., about 5 ppm U-232) from irradiated thorium via isolation and aging of Pa-233; a practical and economic process will be developed. Other new process and product capabilities will be studied to define their potential value to the AEC.

Chemical Safety

As a result of anion exchange resin studies that were prompted by the Building 233-S fire, this activity has been increased and will be re-identified as a separate activity, starting in FY 1966.

Anion exchange hazards were investigated in depth to gain an understanding of the mechanisms which cause violent exothermic nitration-oxidation reactions in resins. Spontaneous ignition of resins has been demonstrated, and the "ignition" threshold temperature has been related to such variables as resin volume (equipment size), nitrate loading, cross linkage, and feed rates. The effectiveness of pressure relief systems for quenching run-away reactions have been demonstrated, and the principle has been applied to installed anion exchange systems. Heats of loading, heats of combustion, heats of degradation, and heats of displacement are being measured to define mechanisms which cause resin temperatures to increase to ignition thresholds.

The resin studies also prompted studies to identify similar hazards involving other unstable compounds in separations plant systems. In addition, investigations regarding the formation and control of radioactive aerosols and particulate matter that might be created by, or associated with, plutonium fires are being extended to separations plant locations where plutonium or other radionuclides could be dispersed into the atmosphere as a result of possible uncontrolled chemical reactions, equipment failure, or fire.

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Equipment and Instrument Development

Research and Development funding of this activity continues to decline as a result of assigning specific equipment development items to process technology programs. With the reduction of funding, subprograms have been combined in this activity.

Noteworthy accomplishments include: 1) the definition of design criteria for a Purex multipurpose dissolver which incorporates a variable width annulus to provide criticality safe dissolution of fuel elements of different U-235 enrichments; and 2) evaluation of the French developed alloy, Uranus S. (This alloy was found to form an electrolytic couple and is, therefore, unsatisfactory when used in combination with 304 series stainless steel. As an isolated material, Uranus S has superior corrosion resistance in contact with acid solutions containing metal salts at high oxidation states, e.g., storing concentrated Purex LWV acidic wastes.)

Increased measurement capability was achieved in a wide range of miscellaneous instrumentation and equipment, including temperature compensation for pH measurements, conductivity measurements in process streams, a valve design enabling remote clean-out, a neutron monitor for in-cell operation, a portable criticality alarm, and demonstration of magnetic flowmeters in remote operations.

By-Products

The level of O2 Research and Development funding of this subprogram has been curtailed and limited to the identification of potential by-products and related technologies outside the scope of the FPCE. In addition, technologies are being developed to identify fission product recovery processes which are compatible with and support Current Processes and Waste Management Programs. In the latter regard, chemical flowsheets were prepared as a basis for B-Plant scope design which integrates waste management with fission product recovery programs. Examples of technological developments resulting from this effort are: 1) A chromatographic ion-exchange process for recovering highly purified Am-241 from Z-Plant solutions was conceived, developed, and

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02 50 10 15 1 - Separations Processes

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By-Products (continued)

demonstrated; 2) The recovery and purification of technetium from waste supernates was demonstrated; 3) A family of sparingly soluble technetium compounds was discovered (tetrapropyl- and tetramethyl-ammonium pertechnetate); and 4) Processes for recovering and separating strontium, cerium, and rare earths have been developed.

Approved:

General Manager
Chemical Processing Department

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Additional Justification for Operating Costs

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OPERATIONS OFFICE

SPECIAL NUCLEAR MATERIALS

PROGRAM

(011)-1

1. Contractor: General Electric Company		Contract No. AT(45-1)-1350	Task No.
2. Project Title: Separations - Current Processes		189 No.	3. Budget Activity No. 02 50 10 15 1 (011)
4. Date Prepared: April 1, 1965	5. Method of Reporting: Annually	6. Working Location: Hanford, 300 Area	
7. Person in Charge: R. E. Tomlinson Principal Investigator: E. E. Voiland, A. M. Platt		8. Project Term Continuing From: To:	

9. Man Years:	FY 196 5	FY 196 6 (BNW)	FY 196 7 (BNW)
(a) Scientific and Technical	5.2	2.0	1.7
(b) Other	1.3	1.4	1.3
Total	6.5	3.4	3.0
10. Costs:	FY 196 5	FY 196 6	FY 196 7
(a) Direct Labor (Including Continuity of Service)	76,000	40,000	37,000
(b) Materials, Technical Services, Subcontracts	82,000	70,000	64,000
Total Direct	158,000	110,000 (100,000)	101,000 (91,000)
(c) Indirect Expenses	33,000	9,000	9,000
Total Operating Cost	191,000	119,000	110,000
(d) Equipment (Obligation)		35,000 (35,000)	34,000 (34,000)
(e) Irradiation Unit Cost			

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02 50 10 15 1 (011) - Current Processes

(011)-2

11. Reactor Concept - Not applicable.
12. Materials - Not applicable.
13. Dates and Titles of Publications (Other than Progress Reports)

a. G. L. Richardson. Purex 1BX-1BS Column Studies, 1964. HW-84473. October 10, 1964.

14. Scope

The current processes sub-program is directed toward increasing adaptability of existing process systems as necessary to meet changing AEC production requirements safely and reducing operating costs.

15. Relationship to Other Projects

This sub-program is highly interrelated with all other programs in Separations Development and with reactor programs that alter chemical processing needs. Because of direct chemical involvement, a particularly close relationship exists with the waste disposal and by-product recovery programs.

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16. Technical Progress in FY 1965

- a. Pilot plant studies were conducted on the use of sodium sulfoxalate formaldehyde as an alternate reductant for plutonium. Severe stainless steel corrosion led to the abandonment of this reagent.
- b. Development of procedures for batch solvent extraction recovery of neptunium and plutonium from Purex process LMW waste was continued, and led to plant tests of the TLA recovery process for removing plutonium and neptunium from LMW acid wastes by extraction with tri-lauryl amine. The results showed that valence control and extraction are feasible but that controlling the precipitation of the amine under plant conditions is difficult.
- c. The improved diluent survey was essentially finished during the year with the testing of South Hampton Oil's "on-stream" product. The availability of this product, equal to n-dodecane in quality, at modest prices, marks the successful end of several years of R&D work on hydrocarbon analysis and testing, and of close cooperation with South Hampton's development program. Engineering studies were made of the use of this diluent in in-plant tests.
- d. Specialty fuel dissolving flowsheets and equipment systems and tail-end waste treatment methods were developed in preparation for in-plant tests.
- e. Studies were made of the technical feasibility, R&D requirements, and the Purex capability for processing UO_2 fuels from Hanford reactors.

17. Expected Results in FY 1966

- a. Laboratory support will be provided for in-plant testing of uranium (IV) as an alternate plutonium reductant. Exploratory studies of other plutonium reductants and development of processes based on the findings will be carried on.

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17. Expected Results in FY 1966 (continued)

- b. Further plant testing of the recovery of plutonium and neptunium from Purex acid wastes will be conducted. Engineering studies of equipment requirements will be made. Economic studies of competitive methods for recovery of these products will be made. The behavior of tri-lauryl amine in nitric acid systems under irradiation will be studied on a fundamental level.
- c. The use of normal paraffin hydrocarbon diluent in Purex will be evaluated. A fundamental study of the mechanism of iodine reaction with solvents and diluents will be initiated.
- d. Processing of zirconium alloy clad N-Reactor fuels will draw increased attention to handling of Zirflex process solutions. Studies will be initiated on the removal of ammonia from these solutions to avoid hazards associated with ammonia-air mixtures and ammonium nitrate.
- e. A new high capacity Purex LBS column with capability for improved uranium separations will be developed.
- f. Radiation resistance of various ion-exchange resins under approximate process conditions (as opposed to static irradiation tests) will be determined and compared. Use of radiation protection agents will be scouted. This work is essential to determining the feasibility and economics of promethium and americium purification, particularly from fuels containing a higher content of transplutonium isotopes.
- g. Studies will be conducted to define Purex requirements for processing of conceptual Hanford fuels at Purex, such as high-enrichment and uranium oxide fuels. As required, studies of the separations processing of conceptual Hanford reactor targets will also be conducted.

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17. Expected Results in FY 1966 (continued)

- h. The mechanism of denitration with sugar requires some fundamental study with respect to the identity and stability of intermediates. This is important from two points of view, 1) the avoidance of tars, and 2) safety.
- i. Fundamental studies of solvents will be continued. This will include: investigation of phenols (BAMBP type) to improve stability and efficiency, and the development of methods of purification and testing of solvents such as D2EHPA (the latter compound, for example, is quite impure as a commercial product).
- j. Analytical methods for improved process and product quality control will be developed. The development of improved emission spectrographic methods for improved plutonium nitrate product quality control is of particular interest. The use of isotopic spike dilutions and applications of neutron activation analyses will be investigated and if the techniques are adaptable to routine use, methods will be developed.

18. Expected Results in FY 1967

Emphasis will continue on developing new technology in support of enriched fuel and thorium processing and improved capabilities for recovery of by-products such as neptunium and transplutonium isotopes.

19. Description and Explanation of Major Materials, Equipment, and Subcontract Items

There are no expenses associated with this program other than those normal to this type of development activity.

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20. Proposed Results

The variety of separations processes to be conducted in Purex (e.g., Th-U²³³, PuTR, NPR fuels up to 2% enrichment, zirconium dissolution, and concurrent recovery of by-products) and the continuing need to minimize equipment corrosion and improve compatibility of these processes require identification and development of improvements in processes, solvents, diluents, and equipment. Use of an alternate reductant, for example U(IV), could result in savings up to one million dollars per year.

21. Proposed Obligations for Related Construction Projects

None

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OPERATIONS OFFICESPECIAL NUCLEAR MATERIALS
PROGRAM

(012)-1

1. Contractors: General Electric Company		Contract No. AT(45-1)-1350	Task No.
2. Project Title: Separations - Innovations and New Business		189 No.	3. Budget Activity No. 02 50 10 15 1 (012)
4. Date Prepared: April 1, 1965	5. Method of Reportings: Annually	6. Working Location: Hanford, 300 Area	
7. Person in Charge: R. E. Tomlinson Principal Investigators: E. E. Voiland, A. M. Platt		8. Project Term: Continuing From: To:	

9. Man Years:	FY 196 5	FY 196 6 (BNW)	FY 196 7 (BNW)
(a) Scientific and Technical	9.3	12.3	14.3
(b) Other	5.8	7.0	9.3
Total	<u>15.1</u>	<u>19.3</u>	<u>23.6</u>
10. Costs:	FY 196 5	FY 196 6	FY 196 7
(a) Direct Labor (Including Continuity of Service)	170,000	229,000	273,000
(b) Materials, Technical Services, Subcontracts	212,000	451,000	574,000
Total Direct	<u>382,000</u>	<u>680,000 (509,000)</u>	<u>847,000 (706,000)</u>
(c) Indirect Expenses	78,000	62,000	80,000
Total Operating Cost	<u>460,000</u>	<u>742,000</u>	<u>927,000</u>
(d) Equipment (Obligation)		59,000 (59,000)	67,000 (67,000)
(e) Irradiation Unit Cost			

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02 50 10 15 1 (012) - Innovations and New Business

(012)-2

11. Reactor Concept - Not applicable.
12. Materials - Not Applicable.
13. Dates and Titles of Publication (Other than Progress Reports)
 - a. J. C. Sheppard. The Extraction of Polonium (IV) and Bismuth (III) from Nitric Acid Solutions by several Organic Solvents. HW-83226. July 20, 1964.
 - b. D. F. Davis, J. B. Kendall, G. A. Nicholson, and S. M. Nielson. Study Flowsheet for Purex Thorium Process Test. HW-83350 RD (SECRET) July 20, 1964.
 - c. E. J. Wheelwright. Cation Exchange Purification of Americium-241 on a Macro Scale. HW-83956. September 4, 1964.
 - d. L. A. Bray. Dissolution of MnO₂ With Sugar -- Protactinium Recovery Program. (Report of Invention) HW-84468. October 8, 1964.
 - e. L. E. Kusler, H. C. Rathvon, and J. M. Bird. Three Kilogram Polonium Production Study. HW-83940. September 4, 1964 (SECRET)
 - f. H. E. Hanthorn. Polonium Production. RL-SEP-34 RD. October 30, 1964. (CONFIDENTIAL)
 - g. R. T. Allemann. Tests of Thoria Pellets and Their Production from Radiant Heat Spray Calcined Thoria by Pressing, Sintering, and High Energy Rate Inspection. HW-80531. February 1964.
 - h. L. L. Humphreys. Hot-Cell Studies on the Separation of Protactinium-233 from Irradiated Thoria by Coprecipitation with Manganese Dioxide. (In preparation. To be issued with a Battelle number).

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02 50 10 15 1 (012) - Innovations and New Business

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14. Scope

Several new potential product areas for production operations have been identified. The objectives of this R&D program is the development of technology in support of processing methods required in these product areas.

Included in the group of potential product areas are the following: (a) "ultra-pure" U-233 (i.e., product containing < 1 ppm U-232 from irradiation of Th-232), (b) "clean" U-233 (i.e., product containing about 5 ppm U-232 from irradiation of Th-232), (c) Po-210 from irradiation of bismuth, (d) Pu-238 from irradiation of Np-237 utilizing a closely coupled irradiation-separation process to improve neutron and dollar economy, and (3) americium recovered from Pu-241 for subsequent irradiation to Cm-242.

The activities planned are both in the areas of adapting and improving on existing process schemes and exploring new methods which may result in marked increases in the feasibility of developing these product areas because of improvements in the cost picture.

It should be noted that the "ultra-pure" U-233 is an available by-product which can be obtained during separation of "clean" U-233 by isolating Pa-233, allowing it to decay, and recovering the U-233 decay daughter essentially free from U-232.

15. Relationship to Other Projects

Some facets of these studies are interrelated with other programs in separations development at other AEC-Contractor sites. In these instances, however, they represent new effort in that either a new approach is being used or adaptation to existing equipment is involved. Specifically, the work on thorium reprocessing is interrelated with programs of high-density thorium production at other AEC-Contractor sites, and Pu-238 from irradiated Np-237 is currently produced at another AEC-Contractor site but not by a closely coupled irradiation-separation system.

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16. Technical Progress in FY 1965

- a. Intensive laboratory and hot-cell support has been provided to the Hanford "clean" U-233 program. Highlights during the year included: 1) recovery and purification of the first demonstration quantity of "clean" U-233; 2) definition of the MnO_2 scavenging process used for Pa-233 removal in the Purex 6-ton test; 3) scouting of spray calcination for the conversion of thorium nitrate; 4) screening of adsorbents for Pa removal or recovery; and 4) development of a sulfate-anion exchange process for recovery of "ultra pure" U-233 (product of Pa-233 decay).
- b. Pilot plant thoria dissolution studies were conducted in a sectional mock-up of the plant multi-purpose dissolvers. Chemical flowsheets and operating conditions were developed to maximize thoria dissolution rates. Potential equipment corrosion problems associated with dissolving and processing irradiated thoria in the Hanford separations plants were evaluated. Modifications to the Purex Plant dissolvers were developed to permit a several-fold increase in dissolution capacity. These modifications have been adopted for the dissolvers currently under construction.
- c. Scouting studies were initiated for means to prepare thorium oxide suitable for recycling at minimum over-all cycle cost, i.e., balance between in-reactor and separations costs. Engineering studies were made of methods for processing thoria target elements in Purex on both small and large-lot bases.
- d. Radiation problems in the processing of U-233 were identified and techniques for solving them were developed. Work was initiated on unitized equipment suitable for conversion of U-233 nitrate to UF_4 with the absolute minimum of product handling to avoid radiation problems associated with growth of decay daughters.
- e. Polonium-210 process development studies were initiated along two approaches: a solvent extraction approach which is intended to rapidly provide technology for adaptation to existing Hanford facilities, and a distillation approach, which, if successfully developed, is intended to meet longer term needs at markedly lower operating costs.

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16. Technical Progress in FY 1965 (continued)

Laboratory studies were completed and pilot plant work was initiated on a solvent extraction process using aqueous nitric acid dissolution of bismuth metal followed by recovery of Po-210 by dibutyl carbitol solvent extraction and pyrometallurgical bismuth reduction to metal for recycle. Bench scale decontamination of the pyrometallurgical bismuth reduction process was achieved. A preliminary study of facility and operating costs involved in the production of polonium was completed.

Laboratory and engineering studies were initiated on a metal volatility process which has the potential for close integration with reactor operation and attendant lower production costs.

- f. Basic polonium chemistry was studied with respect to the following: precipitation of polonium on BiONO_3 , extraction studies with solvents other than dibutyl carbitol (including ethers, ketones, amines, and organophosphorous compounds), and distillation of polonium organic complexes from aqueous solutions. Significant and useful data were obtained in all of these areas. Two other studies received brief attention: electromigration of polonium in solid bismuth and scavenging from the liquid bismuth with cerium. Neither looked promising but some possible modifications of the latter process make it worthwhile to try some new experiments.
- g. The concept of an in-pile aqueous loop of aqueous Np-237 together with a close-coupled process for separating out Pu-238 was re-evaluated with specific reference to application at Hanford and found to be promising. In support of this concept, studies were made of the radiolysis of aqueous Np-237 solutions.
- h. Details of the americium extraction process using DBBP were completed. In addition, back-up studies with different solvents including "Aliquat-336" and extractions from thiocynate systems were carried out.
- i. A study was made of the methods and costs for chemical processing of fuels and targets for several cases of isotope production in a Hanford small graphite-moderated reactor.

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Engineering feasibility of Hanford separations recovery of other isotopes was studied; e.g., tritium and cobalt-60.

17. Expected Results in FY 1966

- a. Intensive support of the Hanford U-233 program will continue. Included are: 1) development of practical processes for the removal of Pa-233 from feed, waste, and product uranium and thorium (in behalf of meeting product specifications, simplifying waste solidification, and recovering "ultra-pure" U-233); 2) the completion and demonstration via hot-cell processing of the sulfate anion exchange process for recovery of "ultra-pure" U-233 using the product of the 6-ton Purex campaign; 3) evaluation of spray calcination for the inexpensive on-plant closing of the thorium cycle (to produce a thoria with good dissolution behavior and acceptably high density for direct reactor use and/or good Sol Gel characteristics); 4) close-coupled processing schemes (such as fluoride volatility) evaluation; 5) close laboratory and hot cell assistance as required for the November 1965 150-ton Purex campaign.
- b. Development effort and engineering studies associated with thoria dissolution will be carried on with particular reference to alternate dissolution techniques, capabilities for dissolving alternate target forms and the achievement of an optimum balance of in-reactor versus out-of-reactor cycle costs.
- c. Studies leading to firm recommendations on equipment for thorium denitration to an oxide suitable for recycle will continue. Emphasis will be on minimum cycle cost with pot, spray, and agitated trough denitrators being considered.
- d. Modifications to plant dissolvers necessary to accommodate uranium enrichments up to 3 per cent U-235 will be defined and engineered.

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17. Expected Results in 1966 (continued)

- e. With the acquisition of glove boxes during the early part of the period, the needed study at high concentrations of polonium will be undertaken. Much of the work carried out during the last year will be repeated at full levels of activity. This includes particularly, solvent extractions with dibutyl carbitol, volatility studies, and co-precipitation studies. Other basic supporting work planned includes: the measurement of diffusion coefficient of polonium in bismuth; investigations of the nature of various polonides including bismuth and some of the rare earth polonides; study of the unknown compounds which exist between polonium and bismuth oxide, the electrodeposition of polonium from solutions compatible with the solvent extraction system.
- f. Development effort on various Po-210 production processes will continue. Solvent extraction process development will be completed and emphasis shifted to longer range lower production cost approaches such as distillation from bismuth metal under conditions specifically adapted to close integration with the reactors.
- g. Engineering feasibility studies of polonium separations concepts will be conducted, and flowsheets will be prepared. Cost comparisons of competitive processes will be made.
- h. Increased attention will be given to new and unique means of producing high purity Pu-238 with maximum utilization of available Np-237. The radiation chemistry of Np-237 solutions will be studied on a modest scale, particularly with respect to valence states and water decomposition and attention will be given to the engineering problems associated with continuous in-reactor loop processing.
- i. Analytical methods will be developed in support of new product and new process developments.
- j. Nuclear and chemical safety reviews associated with the chemical processing and handling of new product forms such as U-233, Pu-238, Po-210, and associated materials will be completed prior to prototypical process tests.

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- k. It is recognized that other R&D work may be required for as yet unspecified new products or a change in emphasis on other programs, particularly in FY 1967. The above proposal is intended to be flexible to the extent of accommodating such changes.

18. Expected Results in FY 1967

- a. Selection of main-line processes for thorium processing will have been achieved in FY 1966. During FY 1967, it is anticipated that process and equipment details for thorium nitrate conversion to the oxide will be evaluated.
- b. Following main-line Po-210 production process selection in FY 1966, detailed attention will be given to process details and optimization.
- c. Development of optimum processes for Pu-238 production will continue with sufficient information developed to permit firming up the chosen process.
- d. By FY 1967, the potential for other products and/or services may become apparent. Studies will be initiated as necessary to meet these needs.
- e. Development of new products will require continued development of dependable analytical methods.
- f. Nuclear and chemical safety reviews will be continued for new product forms and processes prior to introduction into plants and laboratories.

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19. Description and Explanation of Major Materials, Equipment, and Subcontract Items

Equipment obligations are for a variety of laboratory equipment required to support Research and Development investigations, such as: 1) \$35,000 in FY 1966 for a glove box, induction furnace and high vacuum equipment for evaluating polonium-210 - bismuth separations processes based upon volatility concepts; and 2) \$6,000 in FY 1966 for a thermobalance. Much of the equipment falls in the "under \$5,000" category and includes such items as a pyrolyzer for gas chromatography work, laboratory balances for "hot" glove boxes, paper chromatography equipment, electrophoresis equipment and so forth. Prototypical process equipment for demonstrating the close coupled Np^{237} - Pu^{238} cycle will amount to about \$100,000 in FY 1967.

20. Proposed Results

Significant achievements in any of the subject efforts would greatly improve the potential for diversification of activities at the Hanford facility.

In the area of thorium production, the work will provide the technology in support of an anticipated commitment to product multikilogram quantities of U-233 containing little (about 5 ppm, some 1 ppm) U-232 and will lead to lower costs through better integration with existing production operations. R&D in the area of polonium solvent extraction will result in a capability for separating polonium from irradiated bismuth that greatly exceeds the existing capability within the AEC complex. If a polonium volatility process is demonstrated to be feasible, the unit cost of polonium would be markedly reduced. Efforts in the area of developing a neptunium-plutonium separation process closely coupled to the irradiation operation are directed toward reducing the cost of Pu^{238} and increasing the supply through lower recycle loss and reduced inventory of neptunium.

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21. Proposed Obligations for Related Construction Projects

If a large-scale thorium program is authorized, capital costs of one and one-half to two million dollars will be needed to provide criticality safe equipment, and about five million dollars for the thoria densification process are visualized.

If the polonium program is authorized, a capital cost of two to four million dollars would be required, depending on the choice of production scheme, production rates, and timing desired.

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OPERATIONS OFFICE

SPECIAL NUCLEAR MATERIALS

PROGRAM

(020)-1

1. Contractor: General Electric Company		Contract No. AT(45-1)-1350	Task No.
2. Project Title: Separations - Chemical Safety		189 No.	3. Budget Activity No. 02 50 10 15 1 (020)
4. Date Prepared: April 1, 1965	5. Method of Reporting: Annually	6. Working Location: Hanford - 200 East 200 West and 300 Areas	
7. Person in Charge: R. E. Tomlinson Principal Investigator: R. E. Isaacson, A. M. Platt and E. R. Irish		8. Project Term Continuing From: To:	

9. Man Years:	FY 1965	FY 1966 (BNW)	FY 1967 (BNW)
(a) Scientific and Technical	-	0.8	1.0
(b) Other	-	0.2	0.5
Total	-	1.0	1.5
10. Costs:	FY 1965	FY 1966	FY 1967
(a) Direct Labor (Including Continuity of Service)	-	13,000	17,000
(b) Materials, Technical Services, Subcontracts	-	16,000	64,000
Total Direct	-	29,000 (18,000)	81,000 (20,000)
(c) Indirect Expenses	-	3,000	12,000
Total Operating Cost	-	32,000	93,000
(d) Equipment (Obligation)			
(e) Irradiation Unit Cost			

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02 50 10 15 1 (020) - Separations - Chemical Safety

(020)-2

11. Nuclear Concept - Not applicable.
12. Materials - Not applicable.
13. Dates and Titles of Publications (other than Progress Reports)

- a. Fire Incident, 233-S Facility, Chemical Processing Department, November 6, 1963 (April 1964).
- b. Critical Conditions for Ion Exchange Resin Deflagration. G. Jansen, Jr. (Unpublished).

14. Scope

The objective of this program is to provide technology which permits increased safety in the separations and related processes. The program includes: 1) fundamental investigations of chemical and physical changes that could lead to hazardous conditions during various process operations; and 2) the definition of equipment designs and operating limits to preclude the release and dispersion of radioactive aerosols from chemical systems.

15. Relationship to Other Projects

This program is closely related to 02 50 10 20 1 (020) Plutonium Nuclear and Chemical Safety, 02 50 10 15 1 (011) - Separations-Current Processes, and 02 50 60 0 0 (041) - Waste Management - Low Level Waste Disposal. The program activity 02 50 60 0 0 (041) is concerned with the control of radionuclides originating from normal processes whereas the program activity 02 50 10 15 1 (020) includes control of bursts of radionuclides resulting from chemical reactions and fires. Benefits derived will have wide application throughout the AEC complex to such areas where formation and dispersion of aerosols can result from incidents including uncontrolled chemical reactions and fires.

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RICHLANDOPERATIONS OFFICE02 50 10 15 1 (020) - Separations - Chemical Safety(020)-316. Technical Progress in FY 1965

(Previous activities in this area were funded by other programs including those activities listed in Item 15, above. However, results are reported herein to establish continuity.)

- a. Anion exchange hazards were investigated in depth to gain an understanding of the mechanisms which cause violent exothermic nitration-oxidation reactions in resins. Spontaneous ignition of resins has been demonstrated, and the "ignition" threshold temperature has been related to such variables as resin volume (equipment size), nitrate loading, cross linkage, and feed rates. The effectiveness of pressure relief systems for quenching run-away reactions has been demonstrated, and the principle has been applied to installed anion exchange systems. Heats of loading, heats of combustion, heats of degradation, and heats of displacement are being measured to define mechanisms which cause resin temperatures to increase to ignition thresholds.
- b. The stability of ion exchange resins in promethium and technetium service has been demonstrated.

17. Expected Results in FY 1966

- a. The investigation and measurement of mechanisms which cause temperatures to reach ignition threshold temperatures in fixed and moving anion exchange contactor systems will be continued and topical reports will be issued.
- b. Methods will be investigated for reducing levels of radionuclides discharged to the environment from processing plants. For example, technology must be defined to assure that radionuclides, such as radioiodine, radoruthenium, or plutonium, will not be released to the atmosphere in sufficient quantities to be of concern as a result of uncontrolled chemical reactions or fire.
- c. Various chemical systems will be investigated to identify sources of and causes for uncontrolled chemical reactions, particularly systems which utilize organic media and oxidizing agents.

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18. Expected Results in FY 1967

Aerosol formation in chemical systems will be evaluated. Methods and equipment for control of dispersion of aerosols and particulate matter will be developed. Technology identified in the budget activity 02 50 10 20 1 (020), Plutonium - Nuclear and Chemical Safety, Item 17. 2., will be extended to the Separations areas.

19. Description and Explanation of Major Materials, Equipment, and Subcontract Items

Prototypical equipment amounting to about \$50,000 will be needed to develop and demonstrate methods and techniques for preventing the dispersion of radioactive aerosols and particulate matters generated by uncontrolled chemical reactions and/or fires.

20. Proposed Results

Chemical systems will be evaluated to identify hazardous chemical systems and causes for fires in chemical systems which could result in release of bursts of radionuclides to the environment. Methods (including operating limits) and equipment to prevent such incidents or to minimize the consequences of such incidents should result from this program.

21. Proposed Obligations for Related Construction Projects

None. (This program may identify safeguard equipment needs in specific areas to prevent uncontrolled release of radionuclides to the environment.)

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SPECIAL NUCLEAR MATERIALS
PROGRAM

(C30)-1

1. Contractors	General Electric Company	Contract No.	AT(45-1)-1350	Task No.	
2. Project Titles	Separations - Equipment and Instrument Development	189 No.		3. Budget Activity No.	02 50 10 15 1 (03)
4. Date Prepared	April 1, 1965	5. Method of Reporting	Annually	6. Working Location	Hanford - 200 West and 300 Areas
7. Person in Charge	R. E. Tomlinson Principal Investigators: A. M. Platt, J. B. Fecht, Jr.	8. Project Term	Continuing From: To:		

9. Man Years:	FY 196 5	FY 196 6 (BNW)	FY 196 7 (BNW)
(a) Scientific and Technical	6.0	2.6	2.7
(b) Other	3.0	1.5	1.4
Total	9.0	4.1	4.1
10. Costs:	FY 196 5	FY 196 6	FY 196 7
(a) Direct Labor (Including Continuity of Service)	103,000	47,000	49,000
(b) Materials, Technical Services, Subcontracts	119,000	101,000	122,000
Total Direct	222,000	148,000 (88,000)	171,000 (80,000)
(c) Indirect Expenses	45,000	16,000	21,000
Total Operating Cost	267,000	164,000	192,000
(d) Equipment (Obligation)		25,000	60,000
(e) Irradiation Unit Cost			

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02 50 10 15 1 (030) - Equipment and Instrument Development

(030)-2

11. Reactor Concept - Not applicable.12. Materials - Not Applicable.13. Dates and Titles of Publications (Other than Progress Reports)

- a. N. P. Wilburn and W. L. Nicholson. "A Data Logging Gamma Absorptiometer for Routine Uranium Analysis," published in TALANTA (1964).
- b. N. P. Wilburn, Characterization for Automatic Control of a Typical Chemical Process. HW-SA-3313. January 7, 1964. (Presented at the American Society of Quality Control in April 1964.)
- c. J. Dunn. Evaluation of Prototype Air Lift Circulator. HW-81666. April 3, 1964.
- d. W. J. Van Slyke. Improved Redox Prototype Continuous Ion Exchange Contactor - Interim Report. HW-81718. April 8, 1964.
- e. F. S. Stong. Design Criteria, Installation of Wide-Range, Gamma Radiation Recording Instruments. HW-80396. January 14, 1964. (Distributed in June.)
- f. R. G. Oliver. Portable Critical Incident Alarm Operation and Maintenance Manual. HW-83436. July 27, 1964.
- g. M. T. Slind. Pressure Instrument for Fission Product Shipping Casks. HW-83592. August 10, 1964.
- h. N. P. Wilburn and W. L. Nicholson. Non-Linear Model Determination of Concentration Profiles in Two-Phase Countercurrent Extractor. HW-SA-3484. August 18, 1964.

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02 50 10 15 1 (030) - Equipment and Instrument Development

(030)-3

13. Dates and Titles of Publications (Other than Progress Reports) (continued)

- i. R. G. Oliver and F. S. Stong. Memorandum Report, Problems Associated with the Use of Miniature Co-Axial Cable. September 15, 1964. (UNDOCUMENTED)
- j. C. E. Huck and J. D. Lodge. In-Line Plutonium Analysis by Use of Alpha Scintillating Glass and X-Ray Scintillation Techniques. HW-84251. October 14, 1964.

14. Scope

The objective of this program is to provide an improved technology in the areas of construction materials, process equipment, and control systems to support a continued improvement in areas of plant safety, reliability, and operating cost.

The planned activities encompass the development and testing of materials of construction, process equipment, and process control systems often initiated with exploratory research of concepts and carried through to pilot plant testing and engineering evaluation of design concepts.

15. Relationships to Other Projects

These studies are highly interrelated with all other programs in separations development. They especially complement the chemical process development activities and are expected to have beneficial impact on waste disposal and by-product recovery activities.

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02 50 10 15 1 (030) - Equipment and Instrument Development

(030)-4

16. Technical Progress in FY 1965

- a. Improved means of ion exchange contactor resin movement were defined for potential plant application.
- b. The conceptual design of the Purex multipurpose dissolver was confirmed. The effects of slug length and canister tipping geometry were determined for annuli of various widths corresponding to alternate U-235 enrichments which may be processed in the future. A dumping system was successfully demonstrated for 0.94 per cent NPR fuel which requires only slight modification of present canisters. A conceptual design was formulated on a Purex slug dumping machine.
- c. A program was initiated to develop the short arc welding technique for use in welding equipment intended for use in nuclear processing.
- d. A program of evaluating metallic and non-metallic materials for use in separations plant facilities and equipment was continued. A series of neutron absorbing materials were obtained and corrosion resistance evaluated to permit the design of annular dissolvers compatible with processing requirements. Samples of HAPO-20 and Uranus S alloys were corrosion tested. Uranus S was found to form an electrolytic couple with 304 series stainless steel which resulted in high corrosion rates; as isolated material, Uranus S has high corrosion resistance. HAPO-20 alloy can now be obtained commercially at reasonable cost, can be used in combination with other materials, and has four times the corrosion resistance of 304 series stainless steel in nitric acid-hydrofluoric acid service (zirflex process). Future work of this type will be supported by process technology.
- e. A study of galling characteristics of stainless steel was initiated.

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16. Technical Progress in FY 1965 (continued)

- f. Laboratory development on scintillating glass alpha and thin-crystal X-Ray detectors for in-line plutonium analysis was successfully completed. Performance of installed instruments in Purex enabled the removal of less reliable monitors from service. Laboratory studies were initiated to evaluate use of the new detectors for uranium-233 monitoring.
- g. Improvements were made on a wide range of miscellaneous instrumentation and equipment, including temperature compensation for pH measurements, conductivity measurements in process streams, an improved valve design enabling remote clean-out, a neutron monitor of in-cell operation, a portable criticality alarm, and evaluation of magnetic flowmeters in remote operations.
- h. A study was made of the use of gamma ray spectrometry for the detection of "green slugs." The method appears feasible, and the relationship between cost and potential benefit is being evaluated.
- i. A preliminary analysis of instrumentation and process control requirements for remotely operated chromatographic ion exchange columns was completed.
- j. A prototype full-scale 241-AX waste tank circulator was tested in the 200-W Shop basin for hydraulic stability and solids circulation characteristics.

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02 50 10 15 1 (030) - Equipment and Instrument Development

(030)-6

17. Expected Results in FY 1966

- a. Development of the short arc welding technique will be completed. It is expected that this technique can be made generally applicable to fabricating nuclear processing equipment and that it will permit less expensive and more reliable welding than the TIG process.
- b. Beta-gamma interference effects on recently developed plutonium monitors will be evaluated. Specific instrumentation will be provided in support of U-233 processing and new product processes as required.
- c. Development and evaluation will continue on a wide range of miscellaneous instrumentation including instrumentation for cesium-strontium storage containers, high temperature probes for underground waste tank laterals, control systems and sensors for a chromatographic column for promethium recovery, in-cell neutron monitors, and new types of instrumentation to provide nuclear safety while processing enriched fuels in Purex.
- d. Investigation of Purex data mechanization techniques will be completed to the point where a management decision on the level of future effort can be made.
- e. Evaluate electron beam welding under remote operating and high radiation conditions for a closure of waste containers and encapsulation techniques for other fission products outside scope of FPCE Plant.
- f. The development program to control galling of stainless steel will be completed.
- g. Improved analytical methods will be developed. Methods to be investigated include: differential spectrochemical methods, neutron activation methods, and improved spectrographic emission methods.

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02 50 10 15 1 (030) - Equipment and Instrument Development

(030)-7

18. Expected Results in FY 1967

- a. A continued effort is foreseen for improved instrumentation and process equipment to meet specialized plant requirements as new products and processes are introduced.
- b. Application of neutron activation analysis for potential process applications will be demonstrated.

19. Description and Explanation of Major Materials, Equipment, and Subcontract Items

Special material and equipment purchases are a necessary part of the activities under this program, funds for which are incorporated in the over-all budget estimates as based on historical requirements normal to this type of development activity.

20. Proposed Results

Improvements in process reliability, product quality, operational safety, and operating cost are derived from new and better equipment and instrument designs.

1. Proposed Obligations for Related Construction Projects

None

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SPECIAL NUCLEAR MATERIALS

PROGRAM

(051)-1

1. Contractor: General Electric Company		Contract No. AT(45-1)-1350	Task No.
2. Project Title: Separations - By-Products		189 No.	3. Budget Activity No. 02 50 10 15 1 (051)
4. Date Prepared: April 1, 1965	5. Method of Reporting: Annually	6. Working Location: Hanford - 300 and 200-E Areas	
7. Person in Charge: R. E. Tomlinson Principal Investigators: S. J. Beard, A. M. Platt, and E. E. Voiland		8. Project Term Continuing From: To:	

9. Man Years:	<u>FY 1965</u>	<u>FY 1966</u> (BNW)	<u>FY 1967</u> (BNW)
(a) Scientific and Technical	2.6	1.5	1.2
(b) Other	1.5	0.9	0.8
Total	<u>4.1</u>	<u>2.4</u>	<u>2.0</u>
10. Costs:	<u>FY 1965</u>	<u>FY 1966</u>	<u>FY 1967</u>
(a) Direct Labor (Including Continuity of Service)	46,000	28,000	22,000
(b) Materials, Technical Services, Subcontracts	52,000	41,000	42,000
Total Direct	<u>98,000</u>	<u>69,000 (41,000)</u>	<u>64,000 (38,000)</u>
(c) Indirect Expenses	20,000	7,000	7,000
Total Operating Cost	<u>118,000</u>	<u>76,000</u>	<u>71,000</u>
(d) Equipment (Obligation)		2,000 (2,000)	2,000 (2,000)
(e) Irradiation Unit Cost			

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11. Reactor Concept - Not applicable.
12. Materials - Not applicable.
13. Dates and Titles of Publications (Other than Progress Reports)
 - a. F. P. Roberts. Isolation of Technetium from Purex Wastes, Purification, and Reduction to Metal. HW-83683. To be issued.
 - b. R. L. Moore and F. P. Roberts. The Use of Some New Sparingly Soluble Salts of Technetium in Technetium Recovery and Purification. HW-84498. September 3, 1964. (Report of Invention.)
 - c. L. A. Bray and F. P. Roberts. Supplemental Studies on the Separation of Cerium from Trivalent Rare Earths. HW-84101. October 1, 1964.
 - d. G. L. Ritter and P. W. Smith. Waste Management Program - Integration with Fission Product Purification. HW-83058 PT 1 (Unclassified) and HW-83058 PT 2 (SECRET). June 20, 1964.
 - e. S. J. Beard and H. L. Caudill. Technetium Recovery and Storage at B-Plant. HW-83348. July 20, 1964.
 - f. L. R. Michels, J. H. Nordahl, and C. W. Smith. Fission Product Conversion and Encapsulation Plant Study. HW-84326. October 15, 1964.
 - g. G. L. Richardson. The CSREX Process for Co-Extraction of Cesium, Strontium, and Rare Earths - Pilot Plant Studies. HW-81091. March 2, 1964.

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13. Dates and Titles of Publications (other than Progress Reports) (continued)

- h. G. L. Richardson. Recovery of Strontium from Stored Purex Waste by Lead Sulfate Carrier Precipitation - Pilot Plant Studies. BNWL-4.
- i. Letter, L. A. Bray to R. E. Tomlinson. Zirconium Contamination in Sr-90 Product. February 3, 1965.
- j. L. A. Bray. A Process to Remove Zirconium from Purified Strontium-90. BNWC-24. February 5, 1965.
- k. L. A. Bray. Purification of Sr-90 from Magnesium. (Formerly referred to as HW-84507. To be issued with a Battelle number).
- l. M. K. Harmon. Antimony-125. RL-SEP-191. December 29, 1964.

14. Scope

The objective of this program is to develop the technology required to recover specific fission products in the chemical form and purity needed. The source of material is assumed to be the current or stored radiochemical wastes from the Purex process, or the partially treated wastes to be available under the Waste Management Program.

15. Relationship to Other Projects

This program is allied to programs of the Division of Isotope Development outside the scope of the FPCE to recover fission products for beneficial use. This program is specifically oriented to the economic recovery of these materials from Hanford waste, and the concentration and conversion of these materials to forms fixed to prevent dispersion in case of accident during

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15. Relationship to Other Projects (continued)

transfer to other agencies for conversion to end-use form. Close integration with the Hanford Waste Management Program is required to assure that the technologies developed are mutually compatible.

16. Technical Progress in FY 1965

- a. Two plant tests demonstrated the recovery and purification of technetium from waste supernate. A kilogram of technetium was recovered. Purification of the technetium from the first campaign was completed in laboratory facilities and the product reduced to high-purity metal (a portion of this effort was funded by NASA). In the course of this work, a family of sparingly soluble new compounds of technetium (e.g., tetrapropyl ammonium pertechnetate, and tetramethyl ammonium pertechnetate), was discovered and may have process application. An engineering study was made of alternate processes for recovery of technetium by ion exchange from waste supernates, following cesium stripping operations.
- b. Processes were developed for Semiworks use in cerium-TRE separation and the production of promethium concentrates suitable for ion exchange feed. Adoption of NPH (normal paraffin hydrocarbon) diluent was a significant result of the study, as was the successful use of sugar for denitration of rare earth (and technetium) concentrates. Technology was provided for a special processing campaign which successfully recovered aged promethium from suspended sludge in TK-106A. The recovered promethium was separated from iron, lead, and strontium in the Semiworks and then separated from cerium by silver catalyzed persulfate extraction of cerium-IV.
- c. Studies of strontium and cesium loading on zeolite indicate strontium loading kinetics could be improved by carrying on the operation at 70 C. Cesium loadings in the shielded transfer casks may be increased by a factor of three by use of Linde AW-500 zeolite in place of Decalso presently used.

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16. Technical Progress in FY 1965 (continued)

- d. A continuous process for Ce-IV separation from rare earths was demonstrated in cold semiworks studies.
- e. Chemical flowsheets were prepared as a basis for scope design of the B-Plant needs for integrating waste management and fission products recovery programs. Economic studies were made to evaluate the cost of processing power reactor fuel wastes in B-Plant waste management equipment. Costs and the potential impact on Phase III was provided the AEC.
- f. Process engineering studies were made on the potential quantities and quality of antimony-125 that can be recovered from Purex wastes. A summary report was provided the AEC.
- g. A cask loading procedure was devised which removes zirconium impurity (Sr-90 terminal decay product) from purified Sr-90 solutions which have been held in inventory for a significant period of the time prior to load-out. The process is also suitable for use at customers' installations.
- h. A chromatographic ion-exchange process for recovering highly-purified Am-241 from Z-Plant solutions was conceived, developed, and demonstrated. An important advantage of this new process is that it can be operated in equipment designed for promethium purification. Studies were made on the use of this process for recovery and purification of americium from Purex wastes. Gram quantities of americium were recovered from TK-106A along with aged promethium. An engineering study was made on alternate processes for recovery of americium from Purex wastes both in the FPCE Plant and in new peripheral Waste Management facilities.
- i. A preliminary study of the ORNL alum crystallization flowsheet for purification of cesium recovered by the CPD ion exchange process showed the process to be feasible.

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17. Expected Results in FY 1966

- a. Continuous flowsheets for partitioning cerium from rare earths will be demonstrated in plant runs.
- b. Investigate batch contactor-technology for application to cerium-rare earth separation, solvent treatment, and plutonium and neptunium recovery. A test unit will be built, tested, and optimized with respect to each of these applications.
- c. Investigate flowsheets for the recovery of americium from dissolved Purex sludges and guide plant tests on promising flowsheets.
- d. Process chemistry and engineering feasibility studies will be continued to support development of procedures for recovering specific constituents from wastes which represent new separations business. Included are such isotopes and elements as Sb-125, Ra-228, palladium, and rhodium, and alternate processes for Tc-99 recovery (e.g., amine extraction from acidic waste). These studies will include evaluation for use of existing facilities, equipment concepts, and definition of costs.

18. Expected Results in FY 1967

Engineering studies and development work will continue, as required, to meet the needs of fission products recovery programs sponsored by the Division of Production.

19. Description and Explanation of Major Materials, Equipment, and Subcontract Items

There are no unusual expenses anticipated under this program.

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20. Proposed Results

This program is expected to provide the required technology to provide at a reasonable cost, fission product compounds of suitable purity for fabrication into sources.

21. Proposed Obligations for Related Construction Projects

None.

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