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HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DATE

January 20, 1961

TITLE

BIRCH PLANT IMPROVEMENT PROGRAM

AUTHOR

Issued By

J. B. Fecht

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BIRCH PLANT IMPROVEMENT PROGRAM

Issued By

J. B. Fecht
Process Design and Development
Facilities Engineering
Chemical Processing Department

Classified and Controlled and Marked To

January 20, 1961

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BIRCH PLANT IMPROVEMENT PROGRAM

- I. Title - Birch Plant Improvement Program.
- II. Category C - New or Special Products and Processes.
- III. Assigned Responsibility - Chemical Processing Department. Supporting research and development activities will be conducted by Hanford Laboratories Operation.

IV. Description and Status

A. Program Objective

To fully support the AEC program for maximum recovery of neptunium from current separations feed material and other sources as the AEC may consider appropriate to their needs for increasing the availability of neptunium.

B. Need of Justification (Over-all Program)

The AEC has advised Hanford of their urgent need to recover neptunium for use in their various programs. Because of continuity of operations requirements, capital expenditures will be necessary in both the Redox and Purex Plants to meet their request. (1)

C. Activities Relating to Recovery of Neptunium from Current Normal Separation Plant Feed Material

1. Purex Plant

a. Current Activity

Neptunium, associated with irradiated uranium, is accumulated in process solutions as a result of flowsheet adjustments superimposed on the normal production flowsheet. During plant shutdowns, the captive neptunium is extracted from these solutions by processing through the Final Plutonium Cycle and concentrated in the plutonium concentration equipment. The crude concentrate is purified and converted to the oxide in laboratory facilities in the course of developing processes for plant application.

(1) HW-67957, "Separations Program, CPD," L. Zahn, January 12, 1961.

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b. Planned Activity

Anticipated increases in uranium throughputs will require operation of the Purex Plant at full capability beyond second quarter FY-1962. (1) Consequently, separate neptunium recovery facilities that do not interfere with normal production will be required by that date to meet the AEC's requests for maximum neptunium production.

A capital expenditure of \$1,400,000 has been authorized to install neptunium recovery, concentration, purification, and load-out equipment (shipping containers not included) in the Purex Plant. Estimated project schedules, cost estimate breakdowns, and capital expenditure patterns are presented in Appendices A, B, and C. Facilities to be provided by the project are described below.

Two new critically-safe, remotely-operated solvent extraction pulse columns and associated equipment will be installed in the Purex Canyon. These columns will extract and accumulate neptunium by processing a portion of the 3WB stream (the process stream that accumulates neptunium) on a continuous basis in a manner similar to that presently used for neptunium recovery from the 3WB system during plant shutdowns. At infrequent intervals the accumulated neptunium will be purged to a new stripper-concentrator located in the Storage Gallery and concentrated in preparation for final purification. Although neptunium recovery will continue to depend on successful extraction in the HA Column, over-all recovery efficiencies should be higher since only a portion of the accumulated inventory will be subject to loss by HA Column upsets. Likewise, only a portion of the plant inventory will be continuously subjected to HAW equilibrium losses.

Crude neptunium concentrate from Purex and Redox will be processed in a new purification facility located in a new concrete enclosure in the west end of the Purex Storage Gallery (to be called Q Cell). In addition to the new stripper-concentrator, the new facility will include an ion exchange column with associated critically safe process vessels, aqueous make-up vessels, pumps, valves, ventilation, cold services, samplers, a load-in station for Redox neptunium, shielding and containment enclosures. It will use the anion exchange process developed at Hanford to remove the fission products, plutonium, uranium, and concentrator corrosion impurities in the crude neptunium concentrate. A new product loadout station will be provided for loading purified neptunium nitrate into off-site shipping containers.

(1) Ibid

2. Redox Plant

©

a. Current Activity

Neptunium associated with irradiated feed is accumulated in back cycled waste during normal processing by operating the 1A or 1S Columns on an acid flowsheet and the 2D Column on an acid-deficient flowsheet. During plant shutdowns, the captive neptunium is extracted in the 2D Column with an acid flowsheet and stripped into the 2AF Tank through the 1B Column. The neptunium is processed through the Second Plutonium Cycle, treated with ozone, concentrated in the plutonium concentration equipment and loaded out for final ion exchange treatment in the laboratory.

b. Planned Activity

Anticipated increases in uranium throughputs will require operation of the Redox Plant at full capability beyond third quarter FY-1962 (1). Consequently, new neptunium recovery facilities that do not interfere with normal production will be required by that date. A capital expenditure of \$350,000 is planned to install this equipment in the Redox Plant. Of this amount, \$45,000 has been authorized for Title I and II and related management services. Estimated project schedules, cost estimate breakdowns, and capital expenditure patterns are presented in Appendices A, B, and C. Facilities to be provided by the project are described below.

The Redox continuous neptunium recovery system will consist of approximately 40 new jumpers and a draft tube circulator together with existing processing equipment made available by new technology and the installation of a plutonium ion exchange system. The processing scheme will use an acid Precycle flowsheet followed by an acid-deficient Partition Cycle flowsheet. This will cause neptunium to be extracted with the uranium and plutonium in the Precycle and to follow the 2DW waste stream in the Partition Cycle. The 2DW stream will be re-routed to the 1S Column for neptunium extraction (the 1S Column is no longer required for paralleling the 1A Column because of increased 1A Column capacity on an acid Precycle flowsheet). The extracted neptunium will be stripped to the 1O Column, previously used for solvent washing, and recycled to the 2DF Concentrator. Thus, during normal operation neptunium will accumulate in the First Reflux System, comprised of the 2D, 1S and 1O Columns and associated vessels. At infrequent intervals the accumulated neptunium will be transferred to the Second Reflux System, formerly the Third Plutonium Cycle, by switching the 1O Column neptunium

(1) Ibid

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stream from the 2DF Concentrator to the 3AF Vessel. During the transfer, the Second Reflux System will be operated on an acid flowsheet. When the transfer is complete, neptunium will be partitioned from uranium and plutonium by total reflux in the Second Reflux System on an acid-deficient flowsheet. Decontamination of the neptunium product from gross amounts of fission products will then follow by reverting to an oxidizing acid-deficient flowsheet and by batch² ozone treatment. When the neptunium is sufficiently decontaminated, it will be purged to the existing L-2 stripper-concentrator in the 233-S Building for final concentration. The concentrate will be loaded out and shipped to Purex for purification.

In order to make the Third Plutonium Cycle available for incanyon neptunium recovery, the 2BP plutonium stream will receive final processing in a new ion exchange facility to be located in the 233-S Building. The ion exchange contactor will be of the pushed-bed type with associated service vessels. Ion exchange product will be concentrated in the existing plutonium concentrator (L3). To minimize product contamination with metallic impurities, L3 was previously modified so that the bottom loop and rebiller are titanium and tantalum, respectively. L3 will be further modified by replacing the stainless section between the bottom loop and the de-entrainment section with titanium.

D. Activities Relating to Recovery of Neptunium from Sources Other Than Current Normal Separation Feed Material

1. Uranium Recycle at Hanford

a. Current Activity

CPD has collaborated with IPD in preparing a study of a promising approach to increasing the availability of neptunium-recycling E metal at Hanford. ⁽²⁾ This study was transmitted to the AEC ⁽³⁾ recommending implementation of the approach at Hanford as soon as possible. The AEC Division of Production has expressed interest in the program and has advised Oak Ridge to segregate the depleted E metal from Hanford pending further evaluation of the program by the AEC. ⁽⁴⁾ Approximately 34 kilograms of supplementary neptunium could be produced at Hanford

(2) HW-67475, "Supplementary Birch Production," LW Lange and DF Judson, November 21, 1960.

(3) HW-67478, "Uranium Recycle at Hanford," WE Johnson, November 21, 1960.

(4) Verbal Communication from JT Christy, HOO-AEC, December 15, 1960.

during the next seven to eight years by upgrading irradiated E metal and NPR uranium through a blending operation at Oak Ridge (rather than in diffusion cascades) and then recycling the material through Hanford reactors. Such an approach would conserve uranium-236 for use as a source of neptunium-237 in the reactors without incurring major capital costs. Current evaluation of this program would indicate no capital expenditure requirements in the CPD and none are recommended.

b. Planned Activity

The CPD neptunium recovery and purification facilities will have adequate capacity for the supplementary neptunium generated by the E-metal recycle program. The effects on department production, operation and product specifications in view of the potential for minor increases in uranium-237 and plutonium-238 will be studied.

2. Recovery from Existing Stored Separations Plant Wastes

a. Current Activity

At the request of the AEC a very preliminary study was conducted to determine the feasibility, cost and scheduling of recovering neptunium from existing stored separations plant wastes and estimates of recoverable quantities of neptunium from this ensuing operation. (5) A special recovery program would involve a total expenditure of approximately \$10,000,000 including research and development, capital and operating expense. A 24 to 30-month construction period would be required followed by at least a 15-month recovery period. If a 50% net yield were assumed, approximately 14 kilograms of neptunium could be made available. In addition to the unfavorable cost and schedules, the practicality of a mining program could not be thoroughly established until the neptunium-bearing solids in the waste tanks could be characterized and methods developed for mining the tank contents.

Present plans do not include capital expenditures for a mining and processing program for recovery of neptunium from existing stored wastes. It was agreed in discussions with the AEC that laboratory and field studies would be undertaken to develop the requisite technology for the transfer of stored wastes by reshaping the Waste Management Program schedule. This approach would be responsive to both the Waste Management Program needs and neptunium mining operation, and is covered in more detail in the Waste Management Plant Improvement Program. (6)

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- (5) HW-67313, "Birch Recovery from Stored Wastes," WK MacCreedy, November 3, 1960.
 - (6) HW-68099, "Waste Management Program - Separations Plant Improvement Program," BF Campbell, (to be issued).

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b. Planned Activity

There are no planned activities nor are capital expenditures recommended in direct support of recovery of neptunium from existing stored wastes because of unfavorable costs and schedules and the lack of practical mining technology.

3. Other Sources

a. Current Activity - None

b. Planned Activity

Other sources of interest and having potential for increasing neptunium availability through maximizing inventory usage are close coupled separations - reactor systems. Some research and development is planned (7) to evaluate the practicality of close coupled separations - reactor systems, balancing the in-reactor disadvantages of an aqueous system and the EX reactor disadvantages of a non-aqueous system. Neither program can presently support project activities.

E. Considered Alternatives

There is no alternative with respect to independent in-canyon neptunium recovery facilities. If neptunium recovery is to be continued, the anticipated increase in uranium throughputs makes it mandatory that separate in-canyon neptunium recovery equipment be provided at both Purex and Redox.⁽¹⁾ Several in-canyon recovery schemes other than those described were considered, but found less suitable because of low recovery efficiencies, high cost, or doubtful process feasibility.

The final form of the Hanford neptunium product is to be purified nitrate; however, pure oxide and crude nitrate were also considered. Pure oxide appeared to have few advantages for Hanford or the customer except possibly simpler shipping apparatus. Crude nitrate is a less acceptable product for several reasons. The composition of crude nitrate product will depend on the process status, which is dictated by normal processing requirements at the time of the neptunium "spin (total reflux) and purge" operation. Consequently, the composition will vary considerably. Shipping specifications were considered so broad as to be of doubtful value to the customer, thus requiring tailored processing for each shipment. Even with broad shipping specifications, there would be occasional process upsets when crude neptunium could not be shipped because of excessive radiation fields or gross plutonium or uranium contamination of product. Without purification

(1) Op. Cit.

(7) HW- , "Budget for FY-1963 and Revised Budget for FY-1962, Proposal for Research and Development 2724 Activity," VR Cooper, (to be issued).

facilities the crude neptunium would have to be returned to the canyon for rework resulting in interference with normal production and lower over-all recovery efficiencies.

A final disadvantage in shipping crude neptunium was the need for heavily shielded shipping containers and accompanying personnel exposure problems during loading and unloading operations. Purified neptunium can be shipped in simpler containers with minimum exposure problems.

F. Technology In Support

Research and development efforts in support of the neptunium program are presented as a part of the budget proposed for Research and Development for 2724 Activity. (7) Briefly, this work consists of:

- (1) Development of improved recovery methods for the Purex and Redox in-canyon neptunium recovery systems;
- (2) Support of plant start-up activities associated with new neptunium recovery and purification systems;
- (3) Evaluation of the fission product recovery system planned for 221-B Plant for backup recovery system for the Purex Plant;
- (4) Determine characteristics of neptunium-bearing solids in stored Purex and Redox wastes and develop techniques for mining these solids; and
- (5) Evaluation of close coupled separations - reactor systems.

V. Summary of Costs

1. Over-all Capital Outlay
2. Summary of Immediate Future Costs Related to this Program:

	<u>Source of Funds</u>	<u>Capital Expenditures</u>
Authorized and Underway	Equip. & PA&C	\$1,445,000
In Process	Equip.	305,000

(7)
Ibid.

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3. Detail of Cost Estimates:

	<u>Source of Funds</u>	<u>Capital Expenditures</u>
<u>Projects:</u>		
<u>Authorized and Underway</u>		
1. CGC-821, Project Palm - Purex	PA&C	\$1,400,000 (a)
2. CGC-913, Project Birch - Redox	Equip.	45,000 (b)
<u>In Process</u>		
1. CGC-913, Project Birch - Redox.	Equip.	305,000 (b)

Notes:

- (a) Project CGC-821 Proposal, Revision 1, (8) was submitted on September 12, 1960, for a total capital expenditure of \$1,400,000 to provide neptunium recovery and purification facilities in the Purex Plant. Authorization of \$1,400,000 dated October 13, 1960, (Directive No. HW-478, Modification #3) was received for full project action.
- (b) Preliminary Project CGC-913 (9) was submitted September 9, 1960, for an interim authorization of \$45,000 to initiate work on the Redox Birch project. Interim authorization of \$45,000 dated October 10, 1960, (Directive HW-521) was received for Title I, II and related Management Services. A project proposal modification will be submitted in January requesting authorization for full project action.

VI. Significant Changes in Program Scope

There have been no significant changes in the program scope for recovery of neptunium from normal Redox and Purex nitrate feed, as defined in the document, HW-63927, "Palm Plant Improvement Program," dated March 10, 1960. (10)

- ⊙ The program scope has been increased to investigate methods whereby the availability of neptunium could be increased over the next four to eight years to fulfill the urgent program needs of the AEC.

- (8) HW-65705, "Project Proposal, Revision 1 - Project Palm - Purex - Project CGC-821, LW Finch, September 12, 1960.
- (9) HW-66342, "Preliminary Project Proposal - Project Birch - Project CGC-913, RH Silletto, September 9, 1960.
- (10) HW-63927, "Palm Plant Improvement Program," AEC Board, et al, March 10, 1960,

VII. Measurements

The application of measurements to the Birch program is dependent on approval of the program by the AEC. Measurements will be based on:

- (1) Effectiveness in meeting the customers' requests;
- (2) Accomplishment of the program objective with minimum interference with established programs;
- (3) Conformance to established safety practices;
- (4) Economies achieved in implementing the program; and
- (5) By Project attainment of: Schedule, cost, and project objectives.

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APPENDIX A

PROJECT SCHEDULE ESTIMATES

Purex - Neptunium Recovery and Purification

	<u>Start</u>	<u>Complete</u>
Technology	Complete	
Engineering Study and Scope Design	Complete	
Project Authorization (a)	----	2nd Quarter, FY-61
Design (a)	4th Quarter, FY-60	4th Quarter, FY-61
Procurement (b)	1st Quarter, FY-61	2nd Quarter, FY-62
Physical Performance	3rd Quarter, FY-61	1st Quarter, FY-63
Beneficial Use (b)	----	3rd Quarter, FY-62

(a) Authorization of revised Project CGC-821 proposal issued October 13, 1960, for a total of \$1,400,000.

(b) Beneficial use for in-canyon recovery facilities by January 1, 1962. To meet this schedule, Purex recovery and purification facilities must take priority over Redox recovery facilities.

Redox - Neptunium Recovery

	<u>Start</u>	<u>Complete</u>
Technology (flowsheet)	Complete	
Engineering Study and Scope Design	Complete	
Project Authorization (a)	----	2nd Quarter, FY-61
Design	2nd Quarter, FY-61	4th Quarter, FY-61
Procurement	3rd Quarter, FY-61	3rd Quarter, FY-62
Physical Performance	4th Quarter, FY-61	4th Quarter, FY-62
Beneficial Use	----	4th Quarter, FY-62

(a) Authorization of Project CGC-913 issued October 13, 1960, for total of \$45,000 for Title I and II.

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APPENDIX B

CAPITAL EXPENDITURE PATTERN

	<u>Project Palm</u> <u>Purex</u> <u>CGC-821</u>	<u>Project Birch</u> <u>Redox</u> <u>CGC-913</u>	<u>Total</u> <u>Expenditure</u>
<u>FY-1960</u>			
Expenditures to 6/30/60	\$ 32,000	\$	\$ 32,000
<u>FY-1961</u>			
1st Quarter	\$ 29,000	\$	\$ 29,000
2nd Quarter	60,000	8,000	68,000
3rd Quarter	110,000	60,000	170,000
4th Quarter	<u>175,000</u>	<u>68,000</u>	<u>243,000</u>
Sub-Total	\$ 374,000	\$ 136,000	\$ 510,000
<u>FY-1962</u>			
1st Quarter	\$ 301,000	\$ 99,000	\$ 400,000
2nd Quarter	326,000	46,000	372,000
3rd Quarter	173,000	32,000	205,000
4th Quarter	<u>71,000</u>	<u>19,000</u>	<u>90,000</u>
Sub-Total	\$ 871,000	\$ 196,000	\$1,067,000
<u>FY-1963</u>			
1st Quarter	\$ 40,000	\$ 18,000	\$ 58,000
2nd Quarter (and beyond)	<u>83,000</u>		<u>83,000</u>
Sub-Total	\$ 123,000	\$ 18,000	\$ 141,000
TOTAL	\$1,400,000	\$ 350,000	\$1,750,000

APPENDIX C

COST ESTIMATE BREAKDOWN (a)

I. SUMMARY

	<u>Project Palm Purex</u>	<u>Project Birch Redox</u>	<u>Total</u>
A. Engineering and Design	\$ 332,000	\$ 83,000	\$ 415,000
B. Construction Costs			
1. Improvement to Land	-	-	-
2. Buildings	89,000	8,400	97,400
3. Other Structures	-	-	-
4. Utilities	-	-	-
5. Equipment	723,000	180,700	903,700
6. Removal Less Salvage	13,000	7,900	20,900
C. Contingencies	<u>243,000</u>	<u>70,000</u>	<u>313,000</u>
D. Total Project Cost	\$1,400,000	\$ 350,000	\$1,750,000

II. DETAILS OF CONSTRUCTION COSTS

1. Improvements to Land	\$ -	\$ -	\$ -
2. Buildings			
Modification	84,000	8,000	92,000
Temporary Construction	1,000	-	1,000
3. Other Structures	-	-	-
4. Utilities	-	-	-
5. Equipment			
Engineered Equipment	265,000	65,000	330,000
Piping	136,000	36,000	172,000
Jumpers	154,000	45,900	199,900
Electrical	34,000	3,000	37,000
Instrumentation	85,000	17,000	102,000
Ventilation-Process	16,000	2,000	18,000
Temporary Construction	1,000	2,500	3,500
6. Removal Less Salvage			
Removal	-	5,000	5,000
Burial Boxes	8,000	600	8,600
Burial	4,000	2,000	6,000
7. General Overhead	<u>37,000</u>	<u>10,000</u>	<u>47,000</u>
	\$ 825,000	\$ 197,000	\$1,022,000

(a) Cost exclusive of shipping containers.

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