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**Estimated Discard Limits for
Plutonium-238 Recovery Processing
in the Plutonium Processing Building**

D. F. Luthy and W. H. Bond

March 26, 1975

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Miamisburg, Ohio

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ESTIMATED DISCARD LIMITS FOR PLUTONIUM-238 RECOVERY PROCESSING IN THE PLUTONIUM PROCESSING BUILDING

Introduction

This manual is intended as a basis for plutonium-238 recovery costs and as a guide for removal of plutonium-bearing wastes from the gloveboxes to be safely and economically discarded.

Waste materials contaminated with plutonium-238 are generated from in-house production, analytical, process development, recovery and receipts from off-site. The contaminated materials include paper, rags, alpha-box gloves, piping, valves, filters, etc. General categories for all types of plutonium waste have been established by the ERDA and are reflected in this manual.

There are numerous processes used in plutonium recovery, such as dissolution, ultrasonic cleaning, ion exchange, etc. One or more of these processes are needed to extract the plutonium-238 from waste materials, purify it and convert it to an oxide acceptable for reuse.

This manual is presented in two parts: Part I gives a breakdown and brief explanation of the direct costs for plutonium-238 recovery, derived from budget data. Direct costs include direct labor (operating personnel), operational materials and supplies, health physics direct labor, calorimetry labor, analytical labor, and engineering direct labor (total costs for Method I). Budgeted costs for labor and material were used in the derivation of discard limits. The data presented is then used to calculate the cost per hour for recovery, as it applies to the three different methods of calculating discard limits referred to, in this manual, as Method I (calculation stated above), Method II and Method III. The cost for Method II is derived by adding to the cost of Method I, payroll related expenses. Method III is then calculated by adding overhead expenses to the total cost of Method II.

The ERDA has requested three different discard limits, and after examining this manual, will direct Mound Laboratory which method is to be used. Currently, Method I is being used by ERDA directive.

Part II gives a brief description of each type of residue, along with the time required to process the residue and current process efficiency. Process time requirements of the individual processes are combined to develop total man-hours for each category. Efficiencies are established by review of the last twelve-month's process data. In those categories where recovery eliminates burial, the total recovery costs are reduced by the cost of burial. Conversely, when the recovery process contributes a greater amount of wastes than would have been discarded had the recovery not occurred, then the cost of burial for the additional waste is added. Finally, a calculation of the proposed discard level for each category of residue using each method of calculation is presented. The discard calculations for Methods I, II and III are the breakeven points of processing costs, efficiencies and burial credit where applicable, as compared to the current ERDA plutonium-238 standard cost of \$360 per gram.

The use of approved discard limits permits burial of low content contaminated waste materials without separate burial authorization.

Example of the use of the discard limits:

A container of combustible residues (category 801) is transferred from the area of origin to the gamma scanner, where the plutonium-238 content is determined. The cost breakeven point is 0.250 grams/container for Method I. If the measured plutonium-238 content is less than 0.250 grams, the container would be buried, since the cost of recovery is greater than the value of the plutonium-238. If the measured plutonium-238 content is equal to or greater than 0.250 grams, the container would be sent to the appropriate recovery processing area for recovery.

PART I. RECOVERY COST DATA

Introduction

The cost data described below for the three methods of calculating discard limits are estimates of FY-76 costs prepared with reference to the FY-75 Midyear Review.

Direct Labor Costs

Direct Processing Labor	\$170,306
Engineering Direct Labor	39,856
Health Physics Direct Labor	81,420
Calorimetry Direct Labor	12,273
Analytical Direct Labor	96,942
	<u>\$400,797</u>

Operational Materials and Supplies

Maintenance Supplies	\$ 13,909
Warehouse Supplies	28,800
Direct Vendor Supplies	18,000
Expense Equipment	-
	<u>\$ 60,709</u>

Summary of Cost Data

Assumptions: A. Net man-hours per year = 1864 hours.

Total Gross Hours per Year	2,080
Less Average Vacation Hours	(136)
Less Paid Holidays	<u>(80)</u>
Net Man-hours	1,864

B. Budgeted recovery direct processing manpower is 10.0 man-years.

C. Therefore, total budgeted recovery direct processing man-hours is 18,640.

Costs Per Hour for Each Method

	<u>Total Cost</u>	<u>Cost/Hr.</u>
Direct Processing Labor	\$ 400,797	
Operational Materials and Supplies	60,709	
Total Method I Costs	\$ 461,506	\$24.76
Payroll Related Expenses (400,797 x 20.6%)	82,564	
Total Method II Costs	\$ 544,070	\$29.19
Overhead	1,197,652	
Total Method III Costs	\$1,741,722	\$93.44

General Notes

1. Only those categories of residue routinely processed in the Plutonium Processing Building are reported in this study. As other categories require processing, discard limits will be requested when data to determine process times and efficiency are available.
2. For all categories, recovery is at least a three-step process. The first step is to separate the plutonium from the bulk waste material, forming a nitric acid-plutonium solution. The acid solution is then purified by an ion exchange method and finally precipitated as an oxalate and converted to a plutonium dioxide form acceptable for reuse by production. Process times quoted for each category of residue are those times necessary to convert a container of waste residue into an oxide of a purity acceptable to production processing.

PART II. DISCARD CALCULATIONS

Costs Used in Discard Calculations

Method I Cost/Man-Hour	\$ 24.76
Method II Cost/Man-Hour	29.19
Method III Cost/Man-Hour	93.44
Standard Cost/gm of Pu-238 =	360.00

Formula Used in Calculating Discard Limits

1. Breakeven formula for Recovery:
Standard Cost per gram of Pu-238 x Process Efficiency x
Breakeven gram quantity per container = (Process Hours
Required for Recovery x Cost/Hour) + (Cost of Disposal of
recovery waste¹ - Cost of Disposal if unrecovered²)*.

Therefore:

Breakeven quantity per container =

$$\frac{(\text{Process Hrs. Required} \times \text{Cost/Hr.}) + (\text{Adj. Burial Cost})}{\text{Std. Cost/Gram of Pu-238} \times \text{Process Efficiency}}$$

- 1 - Cost of disposal of recovery waste is the cost of disposing of both cartons of discardable solids and discardable solutions after being processed by recovery per container of original material.
- 2 - Cost of disposal, if unrecovered, is the cost of disposing of both cartons of discardable solids and discardable solutions without being processed by recovery, per container of original material.

*Referred to as adjusted burial cost in formula.

The Categories Currently Used by Plutonium Recovery and Their Descriptions

Combustibles

801 - Combustible Residues - Paper, rags, wood, plastic film and other combustibles.

Non-Combustibles

802 - Alpha Box Gloves - Lead-loaded or plain alpha box gloves.

803 - Metal Residues - Contaminated metal objects, equipment, pipes, valves, etc.

804 - Plastic Residues - Heavy plastics, manipulator boots, tygon tubing, etc.

805 - Internal Alpha Box Supply and Exhaust Filters - Primary alpha box filters constructed of asbestos filter media and a fiberboard case with a silicon rubber gasket.

810 - Glass Residues - Glass vials, beakers, and miscellaneous glassware.

812 - Spent Ion Exchange Resin - Resin used in the purification process.

813 - Glass filters and Fiberglass - This material generally originates in glass fiber filters used to filter process solutions.

Compounds

806-807-823 - Clean Plutonium Dioxide Scrap

806 - Clean Plutonium Dioxide Fired at Temperatures less than 700°C.

807 - Clean Plutonium Dioxide Fired at Temperatures Greater than 700°C.

823 - Clean Plutonium Dioxide Microspheres, Plasma Torch Fired.

808 - Clean Plutonium Dioxide, Molybdenum Coated - Molybdenum Coated, Plutonium Dioxide Fuel Particles.

811 - Processing Sludge - Material that accumulates in dissolvers and evaporators and does not dissolve by normal processing.

Solutions

- 816 - Nitrate Solutions - Low-level nitrate solutions generated within PP Building.
- 817 - Ion Exchange Raffinates - Effluent solution from the purification process.
- 818 - Filtrates - Waste solutions from precipitations of plutonium nitrate solutions.
- 819 - Condensates - Generated in the evaporation of solutions.
- 820 - Caustic Bubbler and Scrubber Solutions - Caustic solutions are used in the incinerator bubbler and various scrubbers throughout the building which must be changed when the caustic is spent.
- 814 - Contaminated Mercury - Generated by some analytical processes.

SUMMARY OF DISCARD LIMITS

Category	Description	Processing Hours Required *	Process Efficiency	Adjusted Burial Cost	Discard Limits in Grams per Container		
					Method I	Method II	Method III
801	Burnable Residue	2.2	.80	17.62	<0.250	<0.284	<0.775
802	Alpha Box Gloves	3.8	.55	6.13	<0.506	<0.591	<1.824
803	Metal Residue	7.1	.65	14.27	<0.812	<0.947	<2.876
804	Plastic Residue	5.8	.70	12.36	<0.619	<0.721	<2.120
805	Internal Alpha Box Supply & Exhaust Filters	7.9	.75	29.54	<0.834	<0.963	<2.843
810	Glass Residues	6.3	.65	14.27	<0.728	<0.847	<2.577
812	Spent Ion Exchange Resin	6.7	.70	11.09	<0.702	<0.820	<2.528
813	Glass Filters	7.0	.80	17.68	<0.663	<0.771	<2.332
806	Clean, Low-Fired, Plutonium Solids	13.6	.90	13.75	<1.082	<1.268	<3.965
807	Clean, High-Fired, Plutonium Solids						
823	Clean, Plutonium Dioxide Microspheres						
808	Clean, Molybdenum- Coated Solids	17.1	.80	13.75	<1.518	<1.781	<5.596
811	Processing Sludge	28.2	.80	23.58	<2.506	<2.940	<9.231
816	Nitrate Solutions	0.11/1	.90	1.42	<0.013/1	<0.014/1	<0.036/1
817	Ion Exchange Raffinates	0.114/1	.90	.98	<0.012/1	<0.013/1	<0.036/1
818	Filtrates	0.19/1	.90	0	<0.014/1	<0.017/1	<0.055/1
819	Condensates & Microsphere Wash Solutions	0.114/1	.90	0.04	<0.009/1	<0.010/1	<0.033/1
820	Caustic Bubbler & Scrubber Solutions	0.20/1	.90	14.50	<0.060/1	<0.063/1	<0.102/1
814	Contaminated Mercury	7.0/Pt	.80	1.73	<0.608/Pt	<0.715/Pt	<2.277/Pt

*Standard quantity per container = 1 gallon, unless otherwise stated.