AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

**Cover Sheet for a Hanford
Historical Document
Released for Public Availability**

Released 1994

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

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

RECEIVED
MAY 14 1994
U S F I

DISCLAIMER

This is a **historical document** that is being released for public availability. This was made from the best available copy. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DECLASSIFIED

(CLASSIFICATION)

HANFORD ~~TECHNICAL RECORD~~
GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DOCUMENT NO.

100-1001

SERIES AND COPY NO.

3

DATE

July 13, 1961

☒

SELECTED DATA
THIS DOCUMENT CONTAINS RESEARCH DATA
DEVELOPED IN THE ATOMIC ENERGY ACT
TRANSMITTAL OF DISCLOSURE
CONTENTS IN ANY MANNER TO AN UNAUTHORIZED
PERSON IS PROHIBITED.

TITLE

The Processing of Pu Scrap at Hanford

☐

OTHER OFFICIAL CLASSIFIED INFORMATION

THIS MATERIAL CONTAINS INFORMATION AFFECTING
THE NATIONAL DEFENSE OF THE UNITED STATES
WITHIN THE MEANING OF THE ESPIONAGE LAWS,
TITLE 18, U. S. C., SECS. 793 AND 794, THE TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER
TO AN UNAUTHORIZED PERSON IS PROHIBITED BY
LAW.

AUTHOR

K. G. Grimm

ISSUING FILE

CIRCULATING COPY
RECEIVED 700 AREA

JUL 14 1961
RETURN TO

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED OR WHEN UNAUTHORIZED PERSONS MAY HAVE ACCESS
TO IT. WHEN NOT IN USE, IT MUST BE STORED IN AN APPROVED LOCKED REPOSITORY WITHIN AN APPROVED
GUARDED AREA. WHILE IN YOUR POSSESSION, UNTIL YOU HAVE OBTAINED A SIGNED RECEIPT FROM
THE ISSUING FILE, YOU ARE RESPONSIBLE TO KEEP IT AND ITS CONTENTS WITHIN THE WALLS OF
THIS PROJECT AND FROM ANY UNAUTHORIZED PERSON. ITS TRANSMITTAL TO, AND STORAGE IN YOUR PLACE
OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. IF ADDITIONAL COPIES ARE REQUIRED,
OBTAIN THEM FROM THE RELATING ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED
TO SIGN IN THE SPACE PROVIDED BELOW.

TECHNICAL INFORMATION FILES

ROUTE TO:

PAYROLL NO.

LOCATION

FILES ROUTE
DATE

SIGNATURE AND DATE

W J Garton	1267	27043	7-14-61	up	8-9-61
W J Garton	1267	27043	7-19-61	up	8-9-61

RECORD

COPY MASTER

THIS DOCUMENT HAS BEEN SCANNED
IS STORED ON THE OPTICAL DISK DRIVE

Indefinite Retention

Disposal Date

54-3000-340 (3-57)

AEC-GE RICHLAND WASH

Authority

Authority

(CLASSIFICATION)

DECLASSIFIED

DECLASSIFIED

HW-70361
Page 1

This document consists of
36 pages. No. 3 of
24 copies. Series A

THE PROCESSING OF Pu SCRAP AT HANFORD

By

K. G. Grimm
Manager - Finance
Chemical Processing Department

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of RM Liten

RLD-CG-4, 3-1-94

By J E Savely 3-30-94

Verified By 13K+101F/1, 3 30 94

July 13, 1961

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
RICHLAND, WASHINGTON

~~This document contains Restricted Data as defined in
the Atomic Energy Act of 1954 and its transmittal or
the disclosure of its contents in any manner to an
unauthorized person is prohibited.~~

DECLASSIFIED

DISTRIBUTION

DECLASSIFIED

1. J. J. Courtney
2. B. M. Dobbs/S. A. Spohr
3. W. J. Gartin
4. K. G. Grimm
5. L. M. Meeker
6. P. H. Reinker
7. H. P. Shaw
8. E. O. Swain
9. C. M. Thomas
10. R. E. Tomlinson
11. J. H. Warren
- 12-21. Atomic Energy Commission
22. W. E. Johnson/G. R. MacArthur
23. 300 Files
24. Record Center

DECLASSIFIED

HW-70361
Page 3

THE PROCESSING OF Pu SCRAP AT HANFORD

This study responds to the requests for data on the subject contained in the D. S. Burrows letter entitled "Processing Plutonium Scrap" (symbol FAc:EAS) dated June 30, 1961 and received for reading by Chemical Processing Department Management on July 5, 1961.

Cognizance is also taken of the July 5 teletype from G. F. Quinn requesting an appendix updating the content of our document HW-63560 (Pu Reclamation - January 18, 1960) with regard to safety aspects covered therein. Appendix A of this paper answers this request.

The teletype from G. F. Quinn establishing the agenda for the July 17-18 Washington staff meeting has been considered to the extent feasible in this presentation, and has resulted in the preparation of some added data for use in the meeting.

We answer in succession the numbered requests in the Controller's letter:

1. Schedule No. 1 details Case I and Case II FY 1960 and FY 1961 scrap by Processed and Generated but not processed, as requested. In addition total scrap Generated and beginning and ending scrap inventories for both fiscal years is furnished in order to give you a complete picture on the accumulation of backlog by type of scrap. We also include data with regard to percent scrap losses on present and proposed facilities, in partial satisfaction of your request 5.

At Hanford the Manager directly in charge of the Recuplex and Buttons operation provided the conversion data for working our local classifications of Scrap into the types specified in the Controller's letter

The terminology on Sculls is the same both at Hanford and in the letter.

The following Hanford Scrap classifications were considered as Slag and Crucible:

- A. Reduction Fragments
- B. Casting Fragments

Reject Buttons were the same in both classifications.

The following Hanford accountability classifications were categorized as Miscellaneous Alloys:

- A. CPD Engineering Returns
- B. Hanford Laboratories Engineering Returns

The following were classified as Aqueous Recycle:

- A. Rags and Filters
- B. Buttons Slurry Recycle
- C. Primary Plant Recycle (1960)
- D. Vacuum System Recovery
- E. Miscellaneous Solutions

DECLASSIFIED

HW-70361

Page 4

Hood Wastes were considered as Ash.

The centrifuge Sludge category is carried as Machining Oil at Hanford.

The following were considered as Sweepings.

- A. Task II and Task III Sweepings
- B. Task IV through VII Sweepings
- C. Product Recovery Sweepings

Lab Wastes are carried as "Metal Samples" at Hanford.

We have no inventory in the Graphite or Glass and Metal categories.

Functional descriptions of the various types of waste are provided in the last part of Appendix A.

2. While we have in the past (together with Rocky Flats and Savannah contractors) documented our very serious reservations as to the safety and economic advisability of shipping virtually any scrap off-site, we concluded that this would be an unproductive assumption for the purpose of your study, preventing the development of proper economic parameters for the alternative cases. We have therefore assumed that all scrap could be shipped off-site and maintained this convention throughout the study. Appendix A expresses our thinking on the safety aspect of such a policy and answers to your questions 6 and subsequent develop our estimates on the economies involved.
3. We have related all Hanford scrap to the study categories, as indicated in Schedule No. 1.
4. No response, due to 3, above.
5. Schedules No. 2 through 7 show the requested unit costs, quantities of total throughput, and total costs for conversion and depreciation. In the "New Facility" cases we have assumed that all available scrap would have been worked in both years rather than the actual amount processed. This appears more logical in consideration of the CAC-880 (New Recovery Facility) capability. We have considered both CAC-880 (\$2,900,000) and Incinerator (\$570,000) depreciation on a 20-year life basis for both "New Facility" cases, together with common facility depreciation for housing and support. Full overheads are applied. You will note that the years in which the new facility is operative enjoy a distinct unit cost advantage over the corresponding costs for the "present facility" cases. Total conversion cost for the new facility is appreciably lower than current conversion cost.

Schedules No. 6 and 7 display an even more startling unit cost improvement, indicating, respectively, results assuming HAPO Processing of all scrap (Case I), and HAPO processing all Case I scrap adjusted for anticipated HAPO scrap generation in FY 1964. The low unit costs result from a relatively fixed Button total cost, largely independent of throughput level, and accommodation of added volume by the new reclamation facility with only minor cost additions.

DECLASSIFIED

HW-70361
Page 5

6. As you will recognize virtually all of the requirements of Request 6 were answered in Schedules 2 through 7. Complete back-up data will be brought to the meetings on the 17th and 18th in the event further detail is required. In specific response to the individual parts of this Request:
- (a) Covered in the schedules.
 - (b) We have presumed (as indicated in our response to Request 2) that all scrap can be shipped and therefore no answer is required.
 - (c) Schedule No. 8 is presented in satisfaction of this requirement.
 - (d) The answer to (b) above applies here.
7. (a) Again assuming that all scrap would be shipped, non-capital incremental costs of approximately \$300,000 would be experienced.
- (b) In the event only Slag, Crucible and Reject Buttons were shipped, incremental costs would approximate \$190,000.

Details of these determinations are offered in Schedule No. 9, together with calculations bringing the incremental amounts to budget levels (\$388,000 and \$260,000 respectively).

It should be mentioned that outgoing shipment of our anticipated FY 1964 scrap volume would necessitate a minimum of \$450,000 incremental cost expenditure. Details of this calculation will be brought to the meeting.

At FY 1961 processing rates liquid wastes are generated in excess of 200,000 liters per year. Most of this is from Task I filtrates. If a commercial processor of this material was not concerned about the specifications of the material sent to him it would be theoretically possible to ship these large volumes unconcentrated in large shipping casks.

There are several reasons why this should not be done. The volumes are much too large to handle in tankage that is critically safe by geometry. It could be concentrated, however, on a continuous basis as it is generated and handled entirely in critically safe equipment and containers. Since these volumes must be concentrated at some point before processing, the criticality aspects dictate that they be concentrated as they are generated at HAPO.

Small shipping containers are preferred to large shipping containers since the small containers simplify the problem of providing the container with suitable structural strength and impact resistance. The compartmentation obtained with small shipping containers is extremely valuable from the safety standpoint.

DECLASSIFIED

7 (b) (continued)

The sculls generated in casting process are extremely pyrophoric and reactive. Safety considerations dictate that this material be oxidized and made chemically inert prior to the time they are packaged and shipped. To perform these operations of concentrating liquids and burning sculls it is necessary to build and operate fairly expensive new facilities, since the existing equipment in the Recuplex area cannot be used for the reasons previously stated in the justification for the new plutonium reclamation facility. (See Appendix A for further detail on safety aspects.)

8. Schedule 10 responds to this request.
9. The present Recuplex equipment will be dismantled and retired regardless of whether the decision is made to process commercially on either a partial or complete basis, or proceed with Project CAC-880. The present Recuplex facility cannot handle the current load without undesirably high operating, maintenance and equipment costs. The progressive deterioration of the Recuplex facility is expected to result in not meeting criteria for safe operation. Schedule 10 indicates the retirement data required.
10. Covered in 8 and 10 above. It is possible that \$10,000 to \$20,000 may be realized on surplus sale of some of the panel boards and instruments.
11. If all scrap is shipped off-site, the capital costs for process equipment and containers are believed to aggregate approximately \$2,700,000. If only slag and crucible and reject buttons are shipped off-site, costs are estimated at almost the same capital figure (\$2,700,000), because it would then be necessary to purchase the majority of the equipments envisioned in CAC-880 to support the remaining scrap processing activity. (As the operating costs of the new facilities also continue virtually intact with only these two types shipped off-site, aggregate unit costs become outstandingly high (see Schedule 8). Capital costs for the two assumptions are detailed on Schedule 11.

Economic Factors

Overheads applied to Manufacturing Costs at HAP0 have been approximately 42 to 44 per cent in recent experience. Patently, these costs would not be eliminated or even noticeably lessened by off-site transfer of a function the size of Recuplex. Similarly, services such as bus, laundry, vehicle, heavy equipment, and engineering services would not drop proportionate to decreases in direct costs in connection with elimination of such a relatively small function, because of the necessary "readiness to serve" costs attending such functions. It is our estimate that no more than 65 to 70 per cent of the manufacturing costs involved in Recuplex could be expected to drop out. While this particular drop-out results in minor or nonexistent on-site cost decreases, the aggregate of a number of such moves might result in ultimate decrease of a full cost magnitude.

DECLASSIFIED

HW-70361
Page 7

Buttons total cost is relatively fixed, because of the high degree of mechanization, and added staffing or cost of any substance would not result from even the maximum case envisioned in the Controller's letter. Some added shift costs result from the maximum case we have appended for information purposes, but even with this additive Buttons unit cost remains fundamentally a function of volume throughout.

The posture taken with regard to safety and the costs thereof will of course be a major determining factor.

Two pages of exhibits follow this narrative containing information not requested but considered germane to the subject under discussion.

We are looking forward with interest to the coming conference.

HW-70361

Page 8

DECLASSIFIED

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

HAPO Pu RECOVERY
AGGREGATE UNIT COSTS (FULL COST)

Sundry Exhibits

(Dollar Per Gram)	Present Fac. <u>FY 1960</u>	Present Fac. <u>FY 1961</u>	New Fac. <u>FY 1960</u>	New Fac. <u>FY 1961</u>	<u>Case I</u>	<u>Case I Adjusted for FY 1964 Anticipated HAPO Throughput</u>
Total Cost	\$1.524	\$1.577	\$1.390	\$1.286	\$.674	\$.572
Depreciation	.200	.175	.323	.295	.139	.107
Overheads	.479	.456	.390	.331	.182	.161
Manufacturing Cost	.845	.946	.677	.660	.353	.304
Total Cost	\$1.524	\$1.577	\$1.390	\$1.286	\$.674	\$.572
Recuplex	1.030	1.153	.920	.888	.382	.289
Buttons	.494	.424	.470	.398	.292	.283

HAPO Pu RECOVERY
DETAIL OF TOTAL COSTS

(in thousands of
dollars)

Total Cost	\$3 091	\$3 168	\$3 142	\$3 183	\$3 689	\$4 119
Depreciation	564	530	748	724	755	755
Overheads	967	957	921	904	1 046	1 196
Manufacturing Cost	1 560	1 681	1 473	1 555	1 888	2 168

[REDACTED]

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Sundry Exhibits

HAPO Pu RECOVERY
UNIT COSTS BY TYPE OF FEED (FULL COST)

Per g.	Present Fac. FY 1960	Present Fac. FY 1961	New Fac. FY 1960	New Fac. FY 1961	Case I	Case I Adjusted Anticipated HAPO Throughput	Act el RT	Act el Sec	Future Sec
Sculls and Oxide	\$1.656	\$1.097	\$.672	\$.589	\$.394	\$.361	100		
Slag and Crucible	7.220	15.197*	5.839	6.434	3.457	2.718	3.34	7.30	4.25
Reject Buttons	.956	.815	.661	.567	.377	.349		1.87	1.21
Misc. Alloys	.851	.919	.659	.568	.401	.350	3.71		
Aqueous Recycle	.813	.814	.802	1.204	1.596	.605		1.89	1.21
Ash	.00	.00	7.430	13.496	5.930	4.905	14.99		
Centrifuge Sludge	1.034	1.161	.00	.00	.672	.613	4.31		
Sweepings	.850	.924	.865	.802	.775	.627	4.51	7.30	4.25
Lab. Wastes	1.639	1.079	.637	.570	.384	.353	2.51		
Graphite	.00	.00	.00	.00	1.737	1.093	12.51		
Glass and Metal	.00	.00	.00	.00	2.392	1.463	4.37		
		1.51					1.37	3.68	3.34

* Low thruput raised this unit cost to an untypical level.

[REDACTED]

CONFIDENTIAL

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

HANFORD SCRAP LOADS - FY 1961-62
KGs/Year

Schedule No. 1

Type of Scrap ⁽²⁾	Case I	Case II	Processed ⁽¹⁾		Generated ⁽¹⁾		Gen no. FY 19
			FY 1960	FY 1961 ⁽²⁾	FY 1960	FY 1961	
1. Sculls and Oxide	2 900	199	180.0	326.1	168.7	508.6	(11
2. Slag and Crucibles	214	114 71.5	99.6	44.5	88.3	98.2	(11
3. Reject Buttons	264	600 50	63.4	245.5	61.0	244.1	(2
4. Miscellaneous Alloys	80	46.5	127.5	82.2	140.7	136.1	13
5. Aqueous Recycle	120		523.2	238.1	527.4	219.9	4
6. Ash	40	14	-0-	-0-	22.7	16.4	22
7. Centrifuge Sludge	10	84	1.0	1.1	1.4	.9	
8. Sweepings	40	116	141.5	85.6	147.9	99.4	6
9. Lab Wastes	180	50	6.9	5.9	7.0	15.1	
10. Graphite	31	25	-0-	-0-	-0-	-0-	-0
11. Glass and Metal	5	26	-0-	-0-	-0-	-0-	-0
Total	3 884	600	1 143.1	1 029.0	1 165.1	1 338.7	22

Additional Types Not Included in Above

None

- (1) All figures from Nuclear Materials Operation reports. For FY 1960 - HW-66100, for FY 1961 - from working papers of unissued reports.
(2) Processed calculated on periodic inventory basis.

[REDACTED]

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

Page/2

DECLASSIFIED

Schedule No. 2

FY 1960 Pu RECLAMATION UNIT COSTS BY SCRAP CATEGORY
(PRESENT FACILITY)

<u>Material</u>	<u>Units in kg's</u>	<u>Total Costs in Thousands</u>		<u>Cost Per Gram</u>	
		<u>Conversion</u>	<u>Depreciation</u>	<u>Conversion</u>	<u>Depreciation</u>
1. Skulls and Oxides	178.3	\$ 190.5	\$ 16.8	\$1.068	\$.094
2. Slag and Crucibles	98.6	613.4	49.8	6.221	.505
3. Reject Buttons	62.8	26.7	2.3	.425	.037
4. Misc. Alloys	126.3	41.6	3.4	.329	.027
5. Aqueous Recycle	519.1	151.9	13.4	.293	.026
6. Ash	-0-				
7. Centrifuge Sludge	1.0	.5	.1	.500	.040
8. Sweepings	140.1	46.1	3.7	.329	.026
9. Lab. Wastes	6.9	7.3	.6	1.058	.087
10. Graphite	-0-	-0-	-0-	-0-	-0-
11. Glass and Metal	-0-	-0-	-0-	-0-	-0-
Recovery Composite	1,133.1	\$1,078.0	\$ 90.0	\$.951	\$.079
Buttons	3,889.9	1,449.0	474.0	.373	.121
Over-all Composite		\$2,527.0	\$ 564.0	\$1.324	\$.200

[REDACTED]

[REDACTED]

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 3

FY 1961 RECLAMATION UNIT COSTS BY SCRAP CATEGORY
(PRESENT FACILITY)

<u>Material</u>	<u>Units in kg's</u>	<u>Total Costs in Thousands</u>		<u>Cost Per Gram</u>	
		<u>Conversion</u>	<u>Depreciation</u>	<u>Conversion</u>	<u>Depreciation</u>
1. Sculls and Oxides	323.1	\$ 201.5	\$ 15.9	\$.624	\$.049
2. Slag and Crucibles	43.9	637.5	44.9	14.523	.250
3. Reject Buttons	243.3	87.9	7.0	.362	.029
4. Misc. Alloys	81.1	37.4	2.7	.462	.033
5. Aqueous Recycle	236.2	85.8	6.4	.363	.027
6. Ash	-0-				
7. Centrifuge Sludge	1.1	.8	.1	.682	.055
8. Sweepings	84.4	39.5	2.7	.468	.032
9. Lab. Wastes	5.9	3.6	.3	.604	.051
10. Graphite	-0-				
11. Glass and Metal	-0-				
Recovery Composite	1,019.0	\$1,094.0	\$ 80.0	\$ 1.074	\$.079
Buttons	4,703.3	1,544.0	450.0	.328	.096
Over-all Composite		\$2,638.0	\$ 530.0	\$ 1.402	\$.175

[REDACTED]

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 4

FY 1960 Pu RECLAMATION UNIT COSTS ASSUMING
NEW Pu RECLAMATION FACILITY (CG-880) IN SERVICE
(PROCESSING FY 1960 SCRAP GENERATED AND 6-30-59 BACKLOG)

<u>Material</u>	<u>Units in kg's</u>	<u>Total Costs in Thousands</u>		<u>Cost Per Gram</u>	
		<u>Conversion</u>	<u>Depreciation</u>	<u>Conversion</u>	<u>Depreciation</u>
1. Sculls and Oxides	200.3	\$ 33.9	\$ 6.7	\$.169	\$.033
2. Slag and Crucibles	106.7	453.8	119.1	4.253	1.116
3. Reject Buttons	63.8	10.4	1.8	.163	.028
4. Misc. Alloys	183.7	29.8	5.0	.162	.027
5. Aqueous Recycle	544.2	111.7	69.0	.205	.127
6. Ash	44.2	249.4	58.2	5.643	1.317
7. Centrifuge Sludge	1.4				
8. Sweepings	174.6	55.0	14.0	.315	.080
9. Lab Wastes	7.2	1.0	.2	.139	.028
10. Graphite	-0-				
11. Glass and Metal	-0-				
Recovery Composite	1 326.1	\$ 945.0	\$274.0	\$.713	\$.207
Buttons	4 094.9	1 449.0	474.0	.354	.116
Over-all Composite		<u>\$2 394.0</u>	<u>\$748.0</u>	<u>\$1.067</u>	<u>\$.323</u>

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 5

FY 1961 Pu RECLAMATION UNIT COSTS ASSUMING
NEW Pu RECLAMATION FACILITY (CG-880) IN SERVICE
(PROCESSING FY 1961 SCRAP GENERATED)

Type of Scrap	Units in kg's	Total Costs in Thousands		Cost Per Gram	
		Conversion	Depreciation	Conversion	Depreciation
1. Skulls and Oxides	508.6	\$ 75.8	\$ 18.1	\$.155	\$.036
2. Slag and Crucibles	98.2	463.8	128.9	4.723	1.313
3. Reject Buttons	244.1	34.5	6.9	.141	.028
4. Misc. Alloys	136.1	19.2	3.9	.141	.029
5. Aqueous Recycle	219.9	115.5	61.9	.525	.281
6. Ash	16.4	169.8	45.0	10.354	2.744
7. Centrifuge Sludge	.9	—	—	—	—
8. Sweepings	99.4	31.2	8.9	.314	.090
9. Lab. Wastes	15.1	2.2	.4	.146	.026
10. Graphite					
11. Glass and Metal					
Recovery Composite	1,338.7	\$ 915.0	\$274.0	\$.683	\$.205
Buttons	5,013.0	1,544.0	450.0	.308	.090
Over-all Composite		\$2,459.0	\$724.0	\$.991	\$.295

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 6

FY 1961 LEVEL UNIT COSTS ASSUMING
NEW Pu RECLAMATION FACILITY AND CASE I
(PROCESSING SCRAP FOR ALL THREE SITES)

<u>Material</u>	<u>Units in kg's</u>	<u>Total Costs in Thousands</u>		<u>Cost Per Gram</u>	
		<u>Conversion</u>	<u>Depreciation</u>	<u>Conversion</u>	<u>Depreciation</u>
1. Skulls and Oxide	2,900	\$ 244.5	\$ 51.0	\$.084	\$.018
2. Slag and Crucible	214	554.9	122.5	2.593	.572
3. Reject Buttons	264	18.5	4.0	.070	.015
4. Misc. Alloys	80	6.8	1.9	.085	.024
5. Aqueous Recycle	120	95.0	61.4	.792	.512
6. Ash	40	180.5	45.0	4.513	1.125
7. Centrifuge Sludge	10	2.5	1.3	.250	.130
8. Sweepings	40	12.8	6.6	.319	.164
9. Lab. Wastes	180	13.5	3.0	.075	.017
10. Graphite	31	39.0	5.8	1.258	.187
11. Glass and Metal	5	8.0	2.5	1.600	.500
Recovery Composite	3,884	\$1,176.0	\$305.0	\$.303	\$.079
Buttons	7,568	1,758.0	450.0	.232	.060
Over-all Composite		\$2,934.0	\$755.0	\$.535	\$.139

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 7

NEW P₂ RECLAMATION FACILITY

ADJUSTED CASE I - ANTICIPATED HAPO FY 1964 (AT FY 1961 DOLLARS)

<u>Material</u>	<u>Units in kg's</u>	<u>Total Costs in Thousands</u>		<u>Cost Per Gram</u>	
		<u>Conversion</u>	<u>Depreciation</u>	<u>Conversion</u>	<u>Depreciation</u>
1. Skulls and Oxides	3 300	\$ 217.0	\$ 39.8	\$.066	\$.012
2. Slag and Crucibles	254	518.4	101.1	2.041	.394
3. Reject Buttons	464	25.8	4.7	.056	.010
4. Misc. Alloys	280	15.6	3.1	.056	.011
5. Aqueous Recycle	520	137.3	76.9	.264	.148
6. Ash	60	227.7	49.6	3.795	.827
7. Centrifuge Sludge	20	4.7	1.9	.235	.095
8. Sweepings	240	63.6	19.0	.265	.079
9. Lab Wastes	210	12.2	2.6	.058	.012
10. Graphite	31	20.3	4.8	.655	.155
11. Glass and Metal	5	4.4	1.5	.880	.300
Recovery Composite	5 384	\$1 247.0	\$305.0	\$.232	\$.057
Buttons	9 068	2 117.0	450.0	.233	.050
Over-all Composite		<u>\$3 364.0</u>	<u>\$755.0</u>	<u>\$.465</u>	<u>\$.107</u>

██████████

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

Schedule No. 8

HAPO Pu RECOVERY
AGGREGATE UNIT COSTS (FULL COST)

	<u>Present Fac. FY 1960</u>	<u>Present Fac. FY 1961</u>	<u>New Fac. FY 1960</u>	<u>New Fac. FY 1961</u>	<u>Case I</u>	<u>Case I Adjusted for FY 1964 Anticipated HAPO Throughput</u>
All Scrap Processed (Case I)	\$1.524	\$1.577	\$1.390	\$1.286	\$.674	\$.572
Less Reject Buttons, Slag and Crucible (Case II)	\$1.898	\$2.273	\$1.704	\$1.792	\$.791	\$.672

DECLASSIFIED

██████████

[REDACTED]

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 9

SHIPPING MATERIAL OFF SITE
OPERATING COSTS REQUIRED TO SHIP SCRAP

(a) All Scrap

1	Accountability clerk	
6	Operators (2 incineration and burning sculls, 2 concentrating, 2 packaging)	
2	Maintenance - Chiefly on instruments	
1	Supervisor	
1	RMU	
2	Chemists	
1	Truck driver	
<u>4</u>	Shift operators covering incineration and concentration	
18 x	\$1,000 month (includes salary C/S trans, etc.) = \$18,000 x 12	- \$216,000
Transportation and security shipment costs	40 cans @ \$2,000	<u>80,000</u>
	Incremental Costs	\$296,000
	Overheads	<u>92,000</u>
	Total Budgetary Costs	<u><u>\$388,000</u></u>

(b) Slag, Crucible and Reject Buttons

As above less four operators		\$168,000
10 cars @ \$2,000		<u>20,000</u>
	Incremental Costs	\$188,000
	Overheads	<u>72,000</u>
	Total Budgetary Costs	<u><u>\$260,000</u></u>

[REDACTED]

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 10CAPITAL COSTS ASSOCIATED WITH Pu RECOVERY

	<u>Capital Cost</u>	<u>Accumulated Depreciation 6-30-61</u>	<u>Net Book Value</u>
Present Recuplex Equipment	\$ 1,527	\$ 356	\$ 1,171
Present Button Line Equipment	948	140	808
Common Facilities to House and Support Above*	15,112*	4,783	10,329
New CAC-880 Reclamation Facility	2,900	-0-	-0-
Incinerator CG-813	570	-0-	
Waste Treatment Facility CG-912	575	-0-	-0-
*Building and Structures	10,040	2,727	7,313
Service Equipment	5,072	2,056	3,016

Also used to house fabrication equipment.
(The above facilities are already in existence.)

HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC COMPANY
CHEMICAL PROCESSING DEPARTMENT

DECLASSIFIED

Schedule No. 11

HAPO CAPITAL COSTS ASSOCIATED
WITH OFF-SITE SHIPMENT OF SCRAP

(in thousands)

7000 facilities to Prime Plant
New Pu Reclamation Facility

Slag, Crucible and
Reject Buttons Only

\$2 400

Facilities for Concentrating
Liquid and Burning Sculls

\$1 100

Modify Railroad Cars 2
1

160

80

Buffer's (Outside Containers
for Solutions)

350 @ \$2,000

700

50 @ \$2,000

100

100 @ 7,000
Inside Containers

Solutions 300 @ \$2,000

600

Powder 50 @ \$1,000

50

Metal 50 @ \$1,000

50

S & C 50 @ \$500

25

50

25

Totals

\$2 685

\$2 705

2 655

570

2 655

150

1,100

80

200

50

50

50

1,655

2,005

570

2,225

2,575

*Assume liquid to Prime Plant (initial)
Change processing of solution at 23005
true SE of IX
(1) a new vessel - more solution in
with 23005 - burning of material*

DECLASSIFIED

APPENDIX A

Appendix A was prepared to update Hanford scrap data presented in Document No. HW-63650, "Plutonium Reclamation", W. K. MacCready, January 18, 1960, and in support of Document No. HW-70361. Scrap generation rates, projected to FY 1964, a description of Hanford scrap types and their potentially hazardous properties, and criteria for preparation of scrap for routine shipment are presented. Potential processing of selected scrap in the Hanford separation plants is also discussed.

Elementary flow diagrams of Hanford processes which generate and recover scrap are presented in Figures 1 and 2. The forecast quantities of scrap from these sources are listed in Table I. Current and proposed recovery facilities at Hanford Atomic Products Operation provide adequate capacity to handle all anticipated recovery loads.

Potentially, some of the recycle streams could be made compatible with the Hanford Atomic Products Operation separations plant processes. The materials most adaptable for recycling to Purex and Redox Plants are relatively pure plutonium solutions derived from dissolution of skulls, reject buttons, and similar materials, and filtrates from the plutonium oxalate precipitation process. Other listed recycle streams are incompatible with the separation processes or are considered too variable in nature to risk the possibility of process upsets which might result in poor decontamination or in plutonium being discarded to waste where, currently, it is impractical to recover.

Dissolved metal and skull solutions could be made compatible with the extraction processes at Redox and Purex, and with the ion exchange tail end process at Purex. Recycling to the solvent extraction processes requires dilution of the plutonium solutions to about two to ten grams per liter, depending upon the plant, to maintain nuclear safety in the separations plant equipment. Close composition control to guard against (1) the introduction of solids from incomplete dissolution or from plutonium polymer formation by incorrect dilution procedures, and (2) the introduction of undesirable contaminants, such as uncomplexed hydrofluoric acid (used for dissolution), organic materials, gross impurities, etc., would also be required. Small amounts of finely divided solids and trace amounts of many organic materials are known to cause severe emulsification within the solvent extraction columns, with resultant high process losses, poor decontamination, and subsequent loss of productive capacity. In one instance, a sufficient amount of tricresyl phosphate was leached from a plastic tank liner (tygon) used to store the salting agent at Redox (aluminum nitrate nonhydrate) to disrupt operation for several weeks, and to necessitate the disposal of

DECLASSIFIED

HW-70361

Page A-2

the entire organic solvent inventory, valued at several thousands of dollars. Introduction of uncomplexed hydrofluoric acid into the Purex process would result in severe corrosion to the remotely controlled and maintained process equipment. The most severe limitation, from a processing rate standpoint, however, is the requirement for a dilute feed, due to nuclear safety, and the high degree of utilization of prime productive capacity.

The relatively pure skull and metal solutions are potentially compatible with the Purex tail end ion exchange process. At present, this has not been conclusively demonstrated or process parameters established. It is expected that waste losses from the ion exchange process would be about the same as that from a Recuplex type of solvent extraction flow sheet, but that any undissolved solids remaining after dissolution of the difficult to dissolve oxides would be discarded as waste. In the Recuplex solvent extraction flowsheet, operation with the low concentration, high cost type feeds (slag and crucible) allows addition of these concentrated relatively pure materials to the proper process point, such that the incremental cost is very low, i.e., the total cost of processing large amounts of concentrated solutions plus slag and crucible is but slightly greater than the cost of processing slag and crucible solutions alone. It is not possible to process slag and crucible material in the separations plants due to the high solid content of this material and the impossibility of avoiding post-precipitation effects, even after filtration, as has been demonstrated conclusively in development testing and routine Recuplex operation. These solids are easily tolerated in the present recovery operation.

Filtrates from the oxalate precipitation process are likely compatible with the Purex and Redox solvent extraction process after proper pretreatment. This treatment would involve destruction of the excess oxalic acid, dissolution of any solids, and careful neutralization of the reduction or oxidation potential to avoid inadvertent valence changes in the separation plant process. A plutonium analysis would be required to verify that the concentration is sufficiently low to maintain nuclear safety standards before the solutions could be transferred to geometrically unsafe storage or transfer vessels. Since the plutonium oxalate process of the button line requires constant removal of the filtrate during operation, it is desirable that the recovery process be "close coupled" in order to avoid the necessity for a large storage capacity. Recycling to the separation plants would not only risk the possibility of disruption to productive capacity due to pretreatment errors, but would also make button line operation dependent upon separation plant schedules, or necessitate capital investment for adequate storage facilities.

DECLASSIFIED

HW-70361

Page A-3

Although some plutonium process streams may be compatible with the Purex and Redox processes, recycling on a routine basis would reduce the separation plant capability as recycle processing would require use of prime processing equipment scheduled for the normal uranium and plutonium processing. Production forecasts indicate the need for full separations capacity. If recycling was to be planned, even at the expense of Purex and Redox plutonium processing time, additional capital expense would be involved for such items as on-site shipping containers, loading and unloading facilities, and storage tanks.

An alternative to on-site scrap recovery would be packaging and shipping the materials to an off-site recovery facility. This would involve handling and packaging facilities at Hanford Atomic Products Operation, storage facilities to hold materials ready for shipment and to receive, survey, and decontaminate returned containers, and would require obtaining new shipping containers specifically designed to provide for safe shipment of the various types of scrap.

At Hanford Atomic Products Operation, facilities for concentrating aqueous recycles and a load-out station would need to be installed. In addition, packaging hoods for solid materials would need to be installed. This would include a hood facility for "passivating" metals, such as skull burning and water passivation of calcium. Storage facilities would be required to store loaded containers in critically safe arrays while waiting for shipment and to receive the returned empty containers. Sufficient area must be included for survey and decontamination, as required, for the returned containers.

About five types of shipping containers would have to be designed and procured to provide for shipment of the scrap. In general, each container must be of high structural integrity to contain its contents in a maximum railroad incident; and must be designed to insure against a criticality incident, to provide for sufficient shielding, and to be easily monitored and surveyed. The containers should be compatible with the spirit and intent of the regulations established by the ICC and Bureau of Explosives. Nuclear safety limits should be compatible with the suggested limits given in the Nuclear Safety Guide (TID-7016).

Specific types of containers would be required for:

a. Dry Powders

Oxides (including skulls transformed to oxide)
Fluorides
Hood sweepings
Ash

DECLASSIFIED

b. Slag and Crucible Materials

c. Metal

Reject buttons
Metal alloys

d. Concentrated Solutions

Aqueous recycle
Laboratory waste

e. Centrifuge Sludge

Estimates on quantities of material and packages required for each type are shown in Table I. Preliminary cost estimates for additional equipment and containers, based on 1961 loads, indicates:

<u>Cost</u>	<u>Estimated Cost</u>
Containers	\$1,600,000
Facilities	<u>1,100,000</u>
Estimated Total Added Capital Outlay	\$2,700,000

Significant costs would be incurred for stowing the packages in the railroad cars so that containers could not shift into a critically unsafe array during transit. (Additional costs for which no estimates have been made would be for courier service, which we assume would be mandatory for shipping quantities of plutonium. Personnel radiation exposure and contamination control problems would be at least as great in packaging and shipping the scrap as though the entire recovery job were completed at Hanford. The increased handling required to prepare and package scrap for shipment would very probably require as many operating people to handle the increased manual work loads and to limit the individual personnel exposure to radiation.

DECLASSIFIEDComposition and Hazards ListingGeneral

The radiological, biological, and nuclear hazards associated with handling and processing plutonium are well known and have been adequately documented. These hazards are presented in a brief summarized form, and the unique chemical properties of individual scrap types are documented.

Radiological Hazard Considerations

Plutonium, element 94, is a radioactive, artificially produced element. The form processed at Hanford Atomic Products Operation consists mainly of isotopes 239, 240, and 241, and contains certain residual fission products as well as radioactive decay daughter products. Radiation from these materials consists of alpha, beta, and neutron particulate radiation and gamma electromagnetic radiation. In relation to whole body exposure, the alpha and beta radiation are shielded out completely by normal containment methods required for biological protection, and as such, the alpha radiation becomes significant mainly as a survey index of contamination (analysis of uncontrolled plutonium spread) for biological safety control. Neutron and gamma radiation are more difficult to shield out. The neutron radiation is a function of the isotopic composition of plutonium and the elements associated with the plutonium (alpha particles react with light elements, e. g., fluorine, to produce neutrons). Neutron emission from the plutonium and, particularly, the fluoride compounds is expected to add to the total radiation level of a shipment and must be considered in the design of shipping containers. Gamma radiation, as well as neutron radiation in some work areas, is sufficiently high to severely restrict the amount of work any single individual can accomplish by direct handling methods (i.e., through gloves in a hood or dry box). Based on current experience (i.e., personnel doing hand work, such as maintenance in the precipitation through hydrofluorination hood), it can be expected that manpower requirements for sorting, packaging, and preparing scrap for shipment would necessarily be established by radiation limitations rather than conventional industrial work load practices. Hanford programs, in general, have been aimed at designing processes and equipment to achieve minimum exposure to personnel. It is expected that no serious difficulty will arise in meeting federal (ICC) regulations for carload shipments of scrap assuming the limitations on the quantity shipped are waived. It is assumed, also, that radiological, biological, and nuclear hazards are considered in the integrated design of the containers and car in relation to the maximum credible incident that might occur during transit.

DECLASSIFIED

Biological Hazard Considerations

Plutonium that is ingested or inhaled is assimilated into the skeletal structure of the body. The relatively slow elimination rate and intense alpha particle irradiation of the bone marrow result in the extremely low body tolerance of 0.04 microcurie (about 0.006 milligram). For this reason, plutonium is handled and processed in hoods or dry boxes, or in carefully sealed equipment. Extreme precautions are taken to preclude the possibility of contaminating personnel and property. Considerable capital investment is required to provide a system of integrity, and considerable operating costs are involved in maintaining contamination control. Shipping regulations require the same high degree of contamination control; a high degree of integrity of shipping containers is also required to avoid the possibility of accidental contamination of property and personnel.

Nuclear Hazard Considerations

Means for prevention of the accidental accumulation of super-critical amounts of plutonium must be incorporated, both in the design of processing facilities and in processing or handling operations. Nuclear safety is achieved by (1) the geometry of equipment - a critical configuration cannot be achieved, (2) by plutonium concentration or density - a critical configuration cannot be achieved under prescribed conditions, and (3) administrative control - a critical configuration will not be achieved if prescribed procedures are followed rigorously. Data and recommendations for nuclear safety have been documented in publication TID-7016, Nuclear Safety Guide, as well as other documents.

Plutonium Fires

Plutonium is a pyrophoric metal, with the degree of pyrophoricity or reactivity dependent upon the purity, composition, and degree of subdivision. Pure massive plutonium is relatively stable toward ignition at room temperature, while plutonium turnings may ignite easily from the friction of normal handling. Storage of plutonium in an atmosphere containing water vapor results in the formation of a powdered material on the surfaces that is postulated to be rich in lower plutonium oxides (i.e., PuO_x , where x is less than 2). This material is very pyrophoric and may be ignited in air, at room temperature, by friction, spark, elevated temperature, or chemical reaction with oxidizing agents. After ignition, the temperature is raised sufficiently to sustain combustion of bulk plutonium. With provisions for air circulation and adequate disposal of heat, bulk plutonium burns slowly with a steady glow. The reaction or burning rate increases rapidly with an increase

DECLASSIFIED

in temperature and may become explosive under certain conditions, i.e., high degree of subdivision, highly oxidizing atmosphere, high ambient temperatures.

Burning plutonium will react with carbon dioxide to form plutonium dioxide and carbon monoxide, and will react with water to form plutonium dioxide and hydrogen, which may react with plutonium to form plutonium hydride, which will also oxidize in air to plutonium dioxide and water. These reactions may be more violent than the initial oxidation, particularly if a stream of carbon dioxide or water, intended for fire fighting, should disturb the burning mass and present new surface area before significant cooling can take place. In addition, disturbance of the burning mass with a high velocity jet tends to disperse the plutonium over a greater area and thereby aggravates the attendant radiological problems.

The high reactivity of burning plutonium toward conventional fire fighting materials requires that special training be given to personnel who may be called upon to fight plutonium fires. Normally, burning plutonium is controlled, rather than extinguished, by covering the burning mass with dry magnesium oxide "sand". Usually, the metal will continue to burn, however, at a greatly reduced rate and the danger of fire propagation will be minimized. In an emergency, any dry inert material, such as sand (SiO_2) may be used. Materials which evolve carbon dioxide with heating, such as conventional dry chemical extinguishers, are not suitable. Small fires may sometimes be extinguished by application of a heat sink to lower the temperature below the ignition temperature. Radiological protection measures must be followed in the vicinity of a fire until the extent of contamination spread and control measures are established.

Maximum protection against ignition of the highly pyrophoric forms of plutonium is through preventative measures or by oxidizing these materials under controlled conditions. Normally, materials such as turnings, etc., are handled in an inert atmosphere such as argon. Nitrogen is frequently used, even though plutonium will continue to burn in nitrogen to form the nitride if previously ignited in air and sufficiently high temperatures are achieved. Ignition in nitrogen, however, is extremely difficult. Where it is necessary to handle pyrophoric materials in air in operations such as recovery, where integrity of the pyrophoric form is not required, it is expedient to burn or oxidize the material under controlled conditions. The plutonium oxide formed under these conditions is completely safe from the standpoint of fire hazard. Information on handling pyrophoric metals and fire extinguishing agents for pyrophoric metals is found in:

DECLASSIFIED

1. Article, "Plutonium and Thorium Fires, 1956", by R. B. Smith.
2. "Technique of Inorganic Chemistry, ORNL-3070".
3. "Final Report on Development of Fire Extinguishing Agents for Lithium", Arthur D. Little report to the Atomic Energy Commission - No. C-62839, December 30, 1960.
4. Oral presentation by Dr. J. Holliday, UKAEA, to the Atomic Energy Commission and Contractor Safety Conference, May 24 - 25, 1961.

Scrap Categories

1. Skulls and Oxides

- a. Skulls - Metallic and nonmetallic residues remaining in melt crucible after pouring.

Skulls are moderately pyrophoric immediately after formation, becoming very pyrophoric after storage in air or an atmosphere containing water vapor. A skull is easily ignited and, occasionally, will react rapidly during dissolution, resulting in equipment pressurization. (See "General - Plutonium Fires"). Controlled burning or other deactivation prior to processing or shipping is recommended.

- b. Oxides - Plutonium dioxide formed from controlled burning or oxidation of skulls or other pyrophoric materials, or formed as a process intermediate (calcination step).

No unique chemical hazards are apparent in handling oxide materials.

2. Slag and Crucible

- a. Metal Reduction Slag and Crucible Fragments - Byproducts of the metal reduction reaction (slag) and the remains of the crucible used to contain the reaction.

Slag and crucible fragments contain unreacted calcium metal (about 25 percent total charged), calcium fluoride and oxide, calcium iodide, plutonium fluorides and oxide (possibly plutonium metal), and magnesium oxide. The calcium metal remaining in the mixture presents a moderate fire hazard⁽¹⁾

(1) Dangerous properties of industrial materials, SAX, 1957 Edition.

DECLASSIFIED

when heated or in contact with oxidizing agents. Hydrogen would be evolved with calcium metal in contact with water or acid, and explosive pressures could develop under uncontrolled additions. Slag and crucible material at Hanford Atomic Products Operation is finely ground prior to packaging. This treatment permits sufficient oxidation of the calcium metal before packaging, such that the hazard from unreacted calcium metal is greatly reduced. The degree of "passivation" thus obtained is subject to verification by laboratory analysis. When excess calcium is known to be present, as determined by poor reduction yields, the slag and crucible charge should be "passivated" by drowning in water to destroy the calcium metal prior to shipment.

- b. Casting Crucible Fragments - Magnesium oxide crucible fragments containing small amounts of plutonium metal or oxides.

No unique chemical properties or hazards are apparent in handling this material.

3. Reject Buttons - Plutonium buttons with impurity content or density out of specifications.

This is relatively pure plutonium. No unique chemical properties or hazards are apparent for storage and shipping.

4. Miscellaneous Alloys - Alloys, metallic mixtures, and compounds from reactor fuel and metallurgical research and development programs.

Some of these materials may be sufficiently pyrophoric or may become sufficiently pyrophoric during storage to require oxidation or treatment to reduce reactivity. Each material requires individual consideration. See "General - Plutonium Fires".

5. Aqueous Recycle

- a. Off-Standard Nitrate - Plutonium nitrate solutions from the separations plants that require additional processing prior to metal reduction, usually due to higher than desirable radioactivity levels.

This material is relatively pure plutonium nitrate in nitric acid solution. Radioactivity causes some decomposition of water with evolution of hydrogen and pressurization of the container. The pressure usually reaches a plateau (about 90 psig after 110 days)* The container must be designed to

* HW-24006, "Pressure in Sample Cans After Storage",
P. E. Collins, September 16, 1952.

DECLASSIFIED

withstand the pressure, to contain liquid without leakage, and for easy opening of the pressurized container without gross contamination spread. Gamma radioactivity of this material is somewhat higher than normal, but probably not sufficiently high to cause difficulty in shipping. This material would not be shipped off-site, since provisions can be made to rework it in the separations plants. Processing this material through Recuplex in the past has been expedient to utilize the flexibility of the Hanford complex.

- b. Wet Chemistry Recycle - Filtrate from the plutonium oxalate precipitation.

The filtrate, a mixture of nitric and oxalic acids, contains relatively small concentrations of dissolved plutonium as well as varying amounts of plutonium oxalate precipitate. Most of the impurities in the plutonium nitrate feed for the button line remain in the filtrate. The filtrate generally requires chemical pretreatment or evaporation to destroy the oxalic acid and dissolve the plutonium oxalate prior to recovery processes. Storage of filtrate, particularly after concentration, has properties similar to item 5-a, Off-Standard Nitrates.

- c. Clean-Out - Solutions and slurries from hood sumps, hood clean-ups, vacuum traps, etc.

This material consists of impure dissolved and insoluble plutonium compounds in water or nitric acid or nitric acid-HF mixtures (HF complexed with aluminum nitrate), and originates in hood and equipment clean-outs. The concentration varies over wide limits and would likely require concentration for storage and shipping. Chemical considerations are similar to item 5-a, Off-Standard Nitrates. The solids must be considered in nuclear safety calculations.

6. Ash - Residue remaining after combustion of contaminated materials.*

This material contains plutonium dioxide in combination with the ash content of contaminated combustible materials, such as paper, rags, etc. The highly ignited plutonium oxide is very inert toward conventional dissolution techniques (nitric-hydrofluoric acid mixtures). The ash is relatively bulky and variable in composition. Although Hanford Atomic Products Operation has had limited experience with ash, no unique chemical hazardous properties are anticipated.

* Combustible materials are considered as reduced to ash. Currently, this includes cellulose base materials only, and assumes that the incineration operation would be performed at Hanford. Rubber gloves and plastic materials are considered as leachable. No unique chemical hazardous properties are anticipated in storing or shipping this material.

DECLASSIFIED

HW-70361

Page A-12

9. Laboratory Wastes - Plutonium nitrate and chloride solutions and miscellaneous process solid materials remaining from process sampling programs.

This material originates as residues from analytical procedures and sampled quantities in excess of analytical requirements. Hydrochloric acid, used as an analytical solvent, is extremely corrosive to stainless steel. The chloride-bearing waste is usually first processed in the laboratory to replace the chloride ion with nitrate ion. Metal chips and turnings are pyrophoric and should be oxidized before extended storage and shipment.

10. Graphite - Molds from the casting process, including silicon nitride molds, used at Hanford Atomic Products Operation.

The mold material is inert, with some plutonium metal and oxides penetrating the surface. No unique hazardous chemical properties are apparent in handling this material.

11. Glass and Metal - Broken laboratory glassware and small leachable items.

No unique hazardous chemical properties are anticipated in handling this material.

DECLASSIFIED

The flowchart illustrates the nuclear fuel cycle with various stages and scrap categories. The stages are represented by boxes: Feed Preparation, Precipitation Calcination Hydrofluorination, Metal Reduction, Fabrication, Dissolution, Incineration, Laboratory, Research and Development, and Solvent Extraction. The scrap categories are indicated by numbers (1, 2-a, 2-b, 3, 4, 5-a, 5-b, 5-c, 6, 7, 8-a, 8-b, 8-c, 9) and labels (Combustibles) placed along the flow lines. The flow starts with Redox and Purex inputs to Feed Preparation, which then leads to Precipitation Calcination Hydrofluorination, then Metal Reduction, then Fabrication, then Dissolution, then Incineration, then Laboratory, then Research and Development, and finally Solvent Extraction. The flow lines are labeled with scrap categories: 5-a, 5-b, 5-c, 8-a, 8-b, 8-c, 9, 6, 7, 2-b, 1, 2-a, 3, 4, and Combustibles.

```

graph TD
    Redox[Redox] --> Feed[Feed Preparation]
    Purex[Purex] --> Feed
    Feed --> Precip[Precipitation  
Calcination  
Hydrofluorination]
    Precip --> Metal[Metal Reduction]
    Metal --> Fabric[Fabrication]
    Fabric --> Diss[Dissolution]
    Diss --> Inc[Incineration]
    Inc --> Lab[Laboratory]
    Lab --> Res[Research and Development]
    Res --> Solv[Solvent Extraction]
    Solv --> Feed
    Precip -- 5-b --> Feed
    Metal -- 2-a --> Feed
    Metal -- 8-b --> Feed
    Fabric -- 1 --> Diss
    Fabric -- 7 --> Diss
    Fabric -- 2-b --> Diss
    Fabric -- 8-c --> Diss
    Diss -- 6 --> Inc
    Diss -- 9 --> Lab
    Diss -- 9 --> Res
    Inc -- 4 --> Res
    Inc -- Combustibles --> Lab
    Solv -- 5-a --> Feed
    Solv -- 5-c --> Feed
    
```

Numbers refer to scrap categories.
See scrap description.

FIGURE 1
SCRAP GENERATION AND RECOVERY

DECLASSIFIED

HW-70361

Page A-11

7. Centrifuge Sludge - Residue from filtration of machining cutting oils consisting mainly of impure plutonium oxide, carbonaceous residues, and cutting oil (lard oil or lard oil - perchloroethylene mixtures).

This material is inert, since plutonium is expected to be present as the oxide. No unique hazardous chemical properties are expected, however, gas may be generated under storage conditions from the decomposition of organic materials.

8. Sweepings

- a. Hydrofluorination Powders - Impure plutonium oxalate, oxide and tetrafluoride powders from accumulations within the precipitation through hydrofluorination processing steps.

Material is variable in nature. Depending upon the point of accumulation, the oxalate, oxide, or tetrafluoride may predominate. Also included are powders collected in the hydrofluorination off-gas filter, a mixture of oxide and tetrafluoride collected in a moist condition. Although this material has not been stored for indefinite periods, it may be expected to be corrosive to stainless steel. Depending upon the moisture content, some gas evolution may be expected. No unique hazardous chemical properties are apparent in handling this material.

- b. Reduction Powders - Predominantly impure plutonium tetrafluoride, which may contain spilled calcium metal or occasional mixed charges (calcium, iodine, and plutonium tetrafluoride).

This material originates as floor sweepings in the metal reduction hood, and occasionally as charges which tend to ignite prematurely during the mixing operation. The mixture may be extremely hazardous and may ignite spontaneously in storage unless passivated by "drowning" in water to destroy the calcium metal.

- c. Fabrication Hood Sweeping - Oxides and metal chips combined with impurities collected from the fabrication hoods.

This material originates as floor sweepings from fabrication and machining hoods. It oxidizes easily, however, cutting oils on the surface inhibit reactivity. This material should be oxidized before extended storage and shipment.

RECLAMATION FACILITY**DECLASSIFIED**

DECLASSIFIED

TABLE I
PROJECTED PLUTONIUM SCRAP LOAD

<u>Category</u>	<u>kgs/year</u>
1. Skulls and oxide	1300
2. Slag and crucible	140
3. Reject buttons	200
4. Miscellaneous alloys	200
5. Aqueous recycle	400
6. Ash	20
7. Centrifuge sludge	10
8. Sweepings	200
9. Laboratory wastes	30

Estimated shipping container requirement for the project scrap load:

<u>No. of Containers</u>	<u>Material Contained by Category</u>
600	Outer containers for inserts.
500	Inserts for liquids - category 5, 7, 9
100	Inserts for powders - category 1, 6, 8
50	Inserts for metal - category 3, 4
50	Inserts for slag and crucible - category 2

DATE

FILMED

7/01/94

END