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TECHNICAL DIVISIONS
GENERAL ELECTRIC COMPANY
RICHLAND, WASHINGTON

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December 31, 1948

Atomic Energy Commission
Hanford Operations Office
Richland, Washington

Attention: Mr. R. C. Hageman
Chief, Operations Division

Gentlemen:

BEST AVAILABLE COPY

METAL RECOVERY PROCESSES SURVEY

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6/18/97

Those processes which will yield decontaminated uranium by means of solvent extraction or uranyl ammonium phosphate-fluorination are currently being studied by the General Electric Company in various combinations, in order to determine the most attractive processes from the standpoint of construction cost, time to begin operation, operating cost, engineering design, and process chemistry.

We submit for your information the attached diagram and tables which indicate our present approach toward obtaining the information we need for basing sound recommendations. The present summary is representative of our progress to date. Additional information is expected to result in some revisions.

By March 1, 1949, we expect to have completed the compilation and survey of the data, including estimated construction costs.

In the next few weeks, our activities will be chiefly concerned with the development of construction costs.

The following are the cases or proposals we are studying and comprise the combinations of solvent extraction, bismuth phosphate (Bi PO₄ = present process) and uranyl ammonium phosphate processes to yield uranium hexafluoride as the end product:

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Proposal or Case No.	Process or Combination	Plants made Obsolete	Future Plants in Operation
1.	Bi PO ₄ plus uranyl ammonium phosphate (U.A.P.) for two year old waste	None	Bi PO ₄ plus U.A.P. (at less than maximum capacity)
2.	Bi PO ₄ plus Solvent Extraction (S.E.) for two year old waste	None	Bi PO ₄ plus S.E. (at less than maximum capacity)
3.	Bi PO ₄ plus U.A.P. for aged and current waste	None	Same as 1.
4.	Bi PO ₄ plus S.E. for aged and current waste	None	Same as 2.
5.	Redox plus U.A.P. for old waste	Bi PO ₄ and U.A.P.	Redox
6.	Redox plus S.E. for old waste	Bi PO ₄ and S.E.	Redox
7.	Redox for old and current metal waste	Bi PO ₄	Redox at less than maximum capacity
8.	Solvent extraction to separate Pu from U; Pu processed as at present via Bi PO ₄ . U decontaminated via S.E. plus separate S.E. plant for aged waste	S.E. for aged waste	S.E. for separating Pu from U and decontamination of U; Bi PO ₄ for Pu decontamination
9.	Solvent extraction to separate Pu from U in current waste; Pu decontaminated via Bi PO ₄ , U decontaminated via solvent extraction	None	S.E. for separating Pu from U and decontaminating U operated at less than maximum capacity plus Bi PO ₄ for Pu

We recognize that work has been in progress on other processes for metal recovery -- for example, a straight fluorination process and the electrolytic process. It is our opinion, however, that the U.A.P. and solvent extraction processes are further developed and that design work on either could proceed on the basis of available information. Data may be available shortly on other processes which may lead to the decision to consider these processes and combinations also.

The essential bases we are using in this study are as follows:

1. The nine proposals above are being compared at capacities which will yield four metric tons of decontaminated metal per day from stored and current waste, until the stored waste is totally recovered or reaches the constant inventory as required by Proposals 1 and 2.

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2. All proposals are to yield the hexafluoride as the end product. It is recognized that all steps required to yield this product need not necessarily be conducted at this site, except in those cases wherein fluorination is a required step for decontamination. (Proposals 1, 3, and 5) Unit costs and capacities of other manufacturing locations will be used where applicable in our study.
 3. Consideration is not being given at this time to the details of process revisions which may also yield recovered plutonium from metal wastes. For Proposals 7 and 9, however, a dotted line in the diagram indicates the path of any such desired recovery.
 4. All solvent extraction processes are expected to yield decontaminated uranium nitrate solution.
 5. For solvent extraction processes, waste metal preparation for feed will be by the U.A.P. - caustic metathesis process.
 6. The sluicing method as proposed by both Carbide and Kellex will be used for removal of waste from storage tanks. Kellex construction cost figures for this step will be used where applicable.
 7. The U.A.P. processes will be based on two U.A.P. precipitations. Carbide has provided data to show the satisfactory decontamination obtained by this departure from the proposal of their "Status Report".
 8. Solvent extraction processing will vary as follows:
 - a. For processes in which column feed is prepared directly from current metal (Proposals 5, 6, 7, 8, 9), three uranium cycles will be used.
 - b. For processes in which U.A.P. - Metathesis is used to prepare feed from Bi PO₄ process current and aged waste (Proposals 2, 4, 6, 7, and 9), two uranium cycles will be used.
 - c. For Redox processes, the third cycle waste will be "cribbed".
 - d. For processes utilizing U.A.P. - Metathesis, second cycle wastes in the solvent extraction step will be "cribbed".
- We recognize that "cribbing" of any activity may have to be abandoned. Such a policy will, however, apply to any present or future process considerations.
9. All preparation of the tetrafluoride is to be done via dry methods. Carbide has shown satisfactory decontamination by this means as a step in their U.A.P. processes yielding the hexafluoride as the final product.
 10. A 99+ % yield is assumed for all processes.

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11. For neutralized process wastes which can be concentrated, consideration will be given to concentrating in the plant buildings to a crystallization temperature of 20° C. Further concentration may be considered at the point of final storage.
12. Existing spare or idle facilities (U - Canyon) will be used wherever economically possible in the proposed processes.
13. Construction cost estimates will be made, utilizing in the best possible manner cost data now available on presently proposed construction (Redox). It may also be necessary to bring the cost of existing types of construction to present-day figures in some cases, for the comparison.
14. Value of existing facilities which may be utilized will not be included in construction cost figures. Cost of adaptation will, of course, be added into construction costs.
15. For those proposals in which a plant is built separately for old waste recovery and which is obsolete when the recovery program is completed, we propose a single plant to process waste from both areas (200-E and 200-W).
16. For permanent operations, complete facilities will be provided in both areas. This requirement may be limited to processing of active material; economics should favor centralized processing of decontaminated products.
17. The degree of overdesign incorporated in our study will be essentially the same as for the present Redox design. This includes spare cells and a 20% process capacity safety factor.
18. Remote control and remote maintenance will be proposed in all processing wherein shielding and contamination are involved.
19. The operating year is to be 365 days.
20. Chemical cost figures have been obtained from the Purchasing Division. Fluorine was taken at \$0.50/lb, the figure used by Carbide in its "Status Report".

The attached Block Flow Diagram (H-2-1520) shows, via strip comparison, the essential features of each proposal, together with indicated obsolescence.

The "Comparison of Daily Chemical Costs" is derived from the companion chart, "Comparison of Daily Chemical Consumption and Costs - Unit Processes", which subdivides the consumption into the "units" of each proposal, such as U.A.P. - Metathesis, Solvent Extraction, Fluorination, etc. Costs are shown for the period of metal recovery, as well as on an annual basis after the recovery program has been completed.

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The "Comparison of Storage of Neutralized Stored Wastes" shows the cumulative total gallons of waste to be stored over the period of aged metal waste recovery and also the annual storage after the recovery program has been completed. Costs of storage facilities at forty cents per gallon are also shown.

Very truly yours,

R H Beaton

R. H. Beaton, Head
Separations Technology Division

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UNIT PROCESS

BASES: 1) All unit processes are assumed at a production rate of one metric ton of uranium (U) per day.
 2) All unit processes leading to decontaminated wastes contain costs of U and F₂ required for conversion to UO₂. UO₂ costs are for dry hydrofluorination process. Obvies includes the stoichiometric quantity of HF required for UO₂ plus 10% excess available, electrode from vendor's quotation, plus price bidings plus freight costs, or estimates.
 3) Unit conversion factors are assumed to be 1.00, unless otherwise indicated.

Unit Cost	Material	UO ₂ 27% Waste \$/Tonne	UO ₂ Current Waste \$/Tonne	UO ₂ From Metal \$/Tonne	UO ₂ After HF \$/Tonne	Metathesis 27% Waste \$/Tonne	Metathesis, Out- put Waste \$/Tonne	Index	Solvent Extraction From Metal \$/Tonne	Solvent Extraction From Washings \$/Tonne					
3.48	H ₂ O	13,928	934.54	6,977	203.34	3,164	118.97	11,077	414.50	1,866	73.92	4,000	133.44	18	.48
26.50	KF	1,109.8	304.42	104	28.78	101	24.78	1,478	14.77	-178	-5.47	740	194.10	740	194.10
3.38	Mach	1,109	370.24	6,170	201.71	4,314	164.00	1,778	34.90	900.5	44.02	6,000	200.44	5,490	193.05
5.00	H ₂	2,177	1,108.45									113	5.45	20.5	1.16
20.00	F ₂	3,875	1,193.75									3,875	132.75	3,875	132.75
12.00	Al(OH) ₃	235	2.82	1,713	209.78	974	317.00	20.5	2.48		118.5	11.22			
1.28	F ₂ O			675	11.20	20	20								
15.00	Caustic soda			74.7	11.20	74.7	11.20								
11.00	EM			25	21.58	25	21.58								
2.10	CaO			4,341	91.22										
13.50	(M ₂) ₂ SO ₄			178	24.05	178	24.05								
9.40	H ₂ SO ₄			180	16.92	180	16.92								
355.00	NaOH			30	106.50	30	106.50								
20.00	H ₂ O ₂			8.3	.73	8.3	.73								
11.00	Fe (NO ₃) ₃			32	43.62	32	43.62								
27.51	EMO			14.3	3.98	14.3	3.98								
199.37	EMO			85.7	176.78	85.7	176.78								
34.33	F ₂			11.7	5.59	11.7	5.59								
185.00	La(NO ₃) ₃			11.7	21.58	11.7	21.58								
56.98	Zr carbonate			47	38	47	38								
112.25	Ca (NO ₃) ₂			83	1.05	83	1.05								
2.26	H ₂ O			313	4.53	313	4.53								
8.45	H ₂ SO ₄			1,100	370.18	1,100	370.18								
0	F ₂			20.5	-	20.5	-								
	On wood														
12.00	Al(OH) ₃														
18.00	Fe sulfamate														
11.50	Hexane														
	TOTAL														

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Summary of Daily Process Costs

Notes: 1) All processes are completed at a daily production rate of 1 metric ton of decontaminated wastes. Current stock water is processed at a rate of 2 tons per day and stored water is depleted at a rate of 2 tons per day until an inventory of 2 years is reached in proposal 1, 2, 3, and until all stored water is gone in other proposals.

2) All costs are shown in dollars and cents. The cost of 100% conversion of the final product to 99% DUP costs is \$1.35 per ton of 99% DUP. The cost of 100% conversion of the final product to 99% DUP costs is \$1.35 per ton of 99% DUP. The cost of 100% conversion of the final product to 99% DUP costs is \$1.35 per ton of 99% DUP.

3) Costs shown are summed from the accompanying unit process costs by the formula shown at the column heads, and rounded to the nearest dollar.

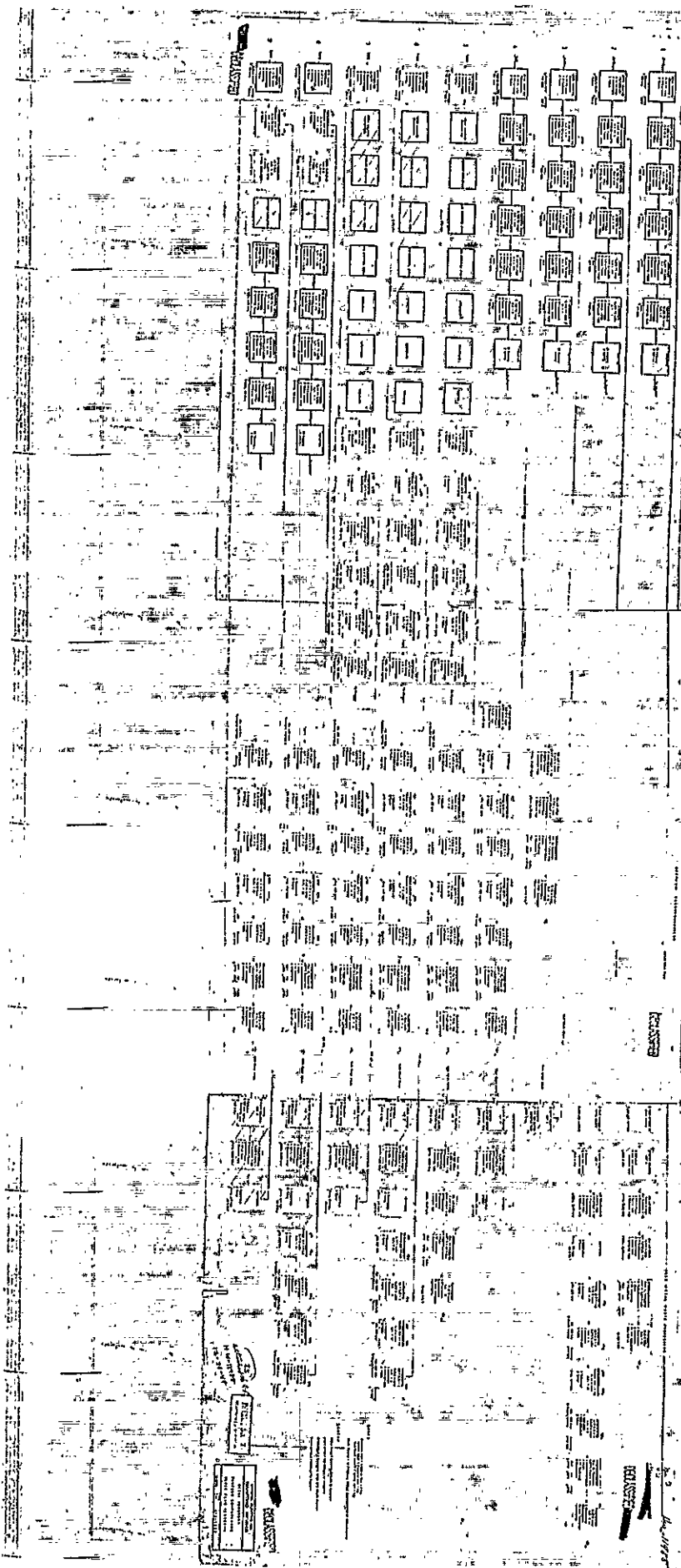
4) Operating year: 365 days.

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Material	1 24.1.24.1	2 24.1.24.1	3 24.1.24.1	4 24.1.24.1	5 24.1.24.1	6 24.1.24.1	7 24.1.24.1	8 24.1.24.1	9 24.1.24.1
NaOH	2,015	2,193	1,874	1,408	1,334	1,141	1,141	1,204	1,204
H ₂ O	1,272	838	1,272	838	1,001	764	764	838	838
NaCl	54	91	435	162	240	673	673	956	956
H ₂ O ₂	435	160	435	160	270	91	91	42	42
H ₂	775	775	775	775	775	775	775	775	775
H ₂ O ₂	435	435	435	435	435	435	435	435	435
Caustic acid	22	22	22	22	22	22	22	22	22
DMF	51	51	51	51	51	51	51	51	51
H ₂ O ₂	162	162	162	162	162	162	162	162	162
(NH ₄) ₂ S ₂ O ₈	43	43	43	43	43	43	43	43	43
NaOH	21	21	21	21	21	21	21	21	21
H ₂ O ₂	21	21	21	21	21	21	21	21	21
Fe (NH ₄) ₂ (SO ₄) ₂ · 6 H ₂ O	91	91	91	91	91	91	91	91	91
DMF	354	354	354	354	354	354	354	354	354
H ₂ O ₂	11	11	11	11	11	11	11	11	11
(NH ₄) ₂ (NO ₃) ₂	43	43	43	43	43	43	43	43	43
Zn carbonate	1	1	1	1	1	1	1	1	1
Ca (NH ₄) ₂ (NO ₃) ₆	2	2	2	2	2	2	2	2	2
NaOH	17	17	17	17	17	17	17	17	17
H ₂ O ₂	1,142	1,142	1,142	1,142	1,142	1,142	1,142	1,142	1,142
H ₂	0	0	0	0	0	0	0	0	0
Ca wool	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700
Al(NO ₃) ₃ · 9 H ₂ O	131	131	131	131	131	131	131	131	131
Fe sulfamate	842	842	842	842	842	842	842	842	842
Revenue	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Total Daily Cost, 1972-73	8,660	8,660	8,660	8,660	8,660	8,660	8,660	8,660	8,660
Annual cost, 1972-73	3,139,000	3,139,000	3,139,000	3,139,000	3,139,000	3,139,000	3,139,000	3,139,000	3,139,000
Sum of Cost, 1969-76 (incl.)	21,657,000	21,657,000	21,657,000	21,657,000	21,657,000	21,657,000	21,657,000	21,657,000	21,657,000
Annual Cost, 1975 and After	4,042,000	4,042,000	4,042,000	4,042,000	4,042,000	4,042,000	4,042,000	4,042,000	4,042,000

* Costs may be reduced by inclusion of H₂O₂ process without reduction.

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