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200 AREA WASTE STORAGE STUDY

Introduction

As a part of the five year budget study requested by HOC-AEC, a study of separations waste storage requirements for this period was made. This study took into consideration the variant estimates of amount of irradiated uranium to be processed, and the goals in the waste reduction research and development program. The conclusions of this study were at variance, to some extent, with prior studies (HW-40698, HW-41211). Interest has been expressed in publication of this study to permit independent assessment of its bases and assumptions.

Conclusions and Recommendations

1. Additional Purex waste storage (241-AX) may be needed September 1, 1958. On the bases of this study, project proposal for this tank farm should be submitted to AEC not later than September 1, 1956. Since Purex is to be operated as the base load plant, only early accomplishment of research and development goals could defer the need for 241-AX. Prudence dictates proceeding with this project.
2. Additional Redox waste storage (241-SY) will not be needed prior to September 1959. Thus, a project proposal for construction of this tank farm need not be considered for submission to AEC before September 1957. On or shortly before this date, a supplemental study should be made to determine how long a decision to construct could be safely postponed, and full advantage of such postponement should be taken. Since Redox is to be operated as the slack load plant, it will feel all variations in load from changes in uranium availability, pile operation, exposure level, etc. Further, improvement in Redox waste storage requirement by research and development is nearing accomplishment. Thus, the waste storage requirements for Redox are inherently less

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predictable than for Purex. Further, the requirement for the maximum foreseeable amount of waste storage is inherently improbable, for if any of several factors varies to the low side, waste storage requirements will be substantially cut. Therefore, deferment of construction of 241-SY to the furthest extent possible, with the idea of ultimate cancellation of the budget item, should be the program.

3. Separations waste storage should be considered plant by plant rather than as a whole. Capital and operating expense would be entailed in making Redox waste tankage available to Purex, and vice versa.
4. Deferment or cancellation of budget items and projects for waste storage should be looked upon as positive accomplishments and not as evidence of bad management. We must budget for waste storage four years before it is needed, and must propose start of construction two years ahead of need. Since the plants cannot operate without waste storage space, good judgment requires conservatism in estimating need when budgeting. Research and development accomplishments over a two-year period may entirely change the waste storage situation.
5. Continuing budget items for cribs, caverns, pumping stations, pipelines, and processing equipment should be provided. All such items are justified on a cost basis, and their service life is unpredictable.

General Considerations

High fission-product activity liquid wastes from the chemical separations plants are stored indefinitely in underground tanks. The cost of waste storage is a fairly important segment of total separations cost. An aggressive program of stored waste volume reduction has therefore been carried on for several years, resulting in sharply reduced requirements for waste tankage. Stages in this program may be briefly listed as follows:

1. Cascading bismuth phosphate second cycle wastes.
2. Evaporating bismuth phosphate first cycle wastes.
3. Scavenging TBP wastes in the tank farms and in the plant.
4. Self-concentration of Redox and Purex high activity wastes.
5. Back cycling of wastes at Redox.

Further studies now in progress are as follows:

1. Cribbing jacket removal wastes.
  2. Improvement in self-concentration operation.
  3. In-plant flowsheet improvements.
  4. Scavenging Redox supernates.
-

5. Design development studies of reduced-cost waste storage facilities.

Slightly-contaminated liquid wastes are disposed of by ground seepage in cribs or caverns. Fission products are adsorbed on the earth particles in an irregular cone-shaped volume. When long-lived fission products (Sr and Cs) are detected at ground water level, the use of the crib or cavern is discontinued. The service life of cribs and caverns is unpredictable; however, all experience to date shows such disposal to be very economical compared to storage. For this reason, every budget should contain an item or items sufficient for construction of three or four cribs, with their associated pipe lines; unused budget items should be deferred to succeeding fiscal years. Supporting facilities such as test wells and the like, required by Radiological Sciences Department, to maintain demonstrated performance in radioactive waste disposal, are also included in these budget items.

Redox and Purex wastes can be permitted to boil by their self-generated radioactive heat in the newer waste tank farms having provision for vapor handling, giving worthwhile savings by self-concentration. After decay of most of the fission product activity, boiling subsides. The non-boiling supernates may safely be transferred to older tanks made available by the metal recovery program, TBP waste scavenging, etc., making space available in the new tanks for more fresh waste. Budget items for waste transfer facilities are justifiable on a cost basis and should be included in every budget.

The success of the scavenging process on TBP wastes has led to consideration of scavenging non-boiling Redox supernates. This research and development program, if successful, will lead to a further reduction in the volume of Redox waste permanently stored.

Financially, waste disposal facilities should be regarded as consumable assets rather than as true capital investments, and the expenditures for these facilities as a pre-paid operating expense. It may be noted that there is a deferred operating expense entailed by waste storage that is not often discussed; this is the expense which will be incurred many years hence for the guarding and careful observation of the waste storage tank farms and their management to avoid surface and ground water contamination.

Reserves

Several million gallons of existing waste storage capacity is being held as reserves; these may be categorized as follows:

1. Reserves for future operation of plants now held in standby condition.
2. Reserves made necessary by design considerations. Need for these reserves may be terminated by results of a plant test now underway.
3. Reserves for possible delay in construction projects.

These categories are discussed further below.

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An assumption which is made in discussion of reserves, as well as for Redox and Purex tankage below, is that the metal recovery program and the TBP waste scavenging program will be completed. Much of the tankage considered as reserve is now occupied with bismuth phosphate metal waste, being recovered in the TBP Plant, and with TBP wastes now being reduced in volume by scavenging.

As shown in the appendix, waste storage tankage reserves for the bismuth phosphate plants total nearly 12 million gallons, and for TBP nearly 7 million gallons. This provides for completion of the TBP program and for somewhat more than six months operation of the bismuth phosphate plants. As long as these plants are regarded as standby, waste storage tankage reserves for their operation must be maintained. It is undesirable, because of costs, to use portions of these reserves temporarily for Redox and Purex wastes, transferring these wastes to new tankage when completed. The above reserves, and waste tankage now filled with what are presently regarded as irreducible wastes (second cycle sludge, evaporator bottoms, TBP scavenging sludge, Redox concentrate and the like), are not considered further in this study.

A further reserve of 9.6 million gallons is presently made necessary by the phenomenon of "bumping" in boiling high activity waste storage tanks. The tanks are now being filled only to the point where the hydrostatic head of the contents (depth in feet times specific gravity times a conversion factor) is equal to ten pounds per square inch, the rated pressure retaining ability of the tank domes. It has been shown that no "bump", to the limit of possible severity, can produce a steam pressure in the tank greater than the hydrostatic head. With the provision of circulators, the frequency and intensity of bumping has been reduced to the vanishing point. Plant tests are underway leading to the reduction or waiving of this limitation, and a decision is expected not later than January 1, 1958. This reserve is shown graphically on the curves for Redox and Purex which follow.

Because of potential delays in prosecution of project proposals, in design and in construction of tank farms, it appears prudent to provide a reserve of storage capacity for these contingencies. Six months is suggested. This reserve is shown graphically on the charts for Redox and Purex which follow. In the construction schedules shown on the charts, it is assumed that complete designs for new tank farms are on hand.

Active Separations Plants

The waste disposal program is presented for the two separations plants in active status--Redox and Purex. Zero waste storage volume on the charts is taken as of January 1, 1956, with full allowance for metal recovery and scavenging operations during the next two years. Details of the status of all of the waste tanks on the plant are given in the appendix. The status and the assignment of space are from HW-40816 and HW-40698 by D. E. Peterson. Summations and remarks are by the author.

The form of the charts is that of Figure 2 of HW-41214, FY-1958 Budget Study, by V. W. Wood. This form is strikingly informative, illustrating clearly the necessity for an immediate decision to construct waste tankage at Purex, since it is not possible to delay construction until completely adequate information is available. The charts also show the effect of slack loading of Redox (divergence of curves B and C, Figure 2, shows the difference between full loading of the plant, curve C, and actual load predicted, curve B), and the fact that R & D work, if successful, shows

an almost immediate effect at Redox but does not become really effective at Purex until 1960. The effect of the comparatively large amounts of storage space available in 200 W Area in allowing a "wait-and-see" policy for Redox is apparent. To attempt to show the entire 200 Area waste disposal program on one chart leads to confusion and false confidence in the availability of waste tankage to a given plant. Therefore, separate charts are given for Redox and Purex.

Several sets of assumptions are used in constructing the various curves of waste storage consumption on the charts. These are tabulated below:

Uranium Processing Estimates, Tons/Yr

<u>Calendar Year</u>	<u>Budget Assumption HW-39825</u>	<u>Pile Engineering Estimate</u>	<u>AEC Estimate of Available Uranium</u>
1956	5700	5371	
1957	9000	6169	7370
1958	10800	7318	8160
1959	12700	7620	(10200)
1960	12700	8164	(10800)
1961	12700	9194	(12700)

Figures in parentheses are extrapolation of the AEC estimates toward the budget assumption.

Estimated Split of Production Between Redox and Purex

<u>Calendar Year</u>	<u>AEC Estimate of Available U</u>		<u>Pile Engineering Estimate</u>	
	<u>Redox</u>	<u>Purex</u>	<u>Redox</u>	<u>Purex</u>
1956	2400	3300	2400	2971
1957	2400	4970	2400	3769
1958	2760	5400	2518	4800
1959	3600	6600	1620	6000
1960	3600	7200	2164	6000
1961	3600	9100	1994	7200

Waste Storage Consumption At Redox

<u>Item</u>	<u>Present</u>	<u>Goal</u>	<u>Budget Assumption</u>
Total waste, gal/TU	2200	1600	2200
Coating waste	250	250	250
High activity waste	1750	1350	1750
Self-concentration	1300	900	550
Final Volume stored	650	450	1400
Plus coating waste	250	0	250
Total waste stored	900	450	1650
Volume reduction by scavenging		200	
Final waste volume stored	900	250	1650

Data on present consumption from E. T. Merrill; on goal consumption from R. E. Smith.

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Waste Storage Consumption At Purex

<u>Item</u>	<u>Present</u>	<u>Goal</u>	<u>Budget Assumption</u>	
			<u>First 300 Tons</u>	<u>Subsequent</u>
Total waste, gal./TU	950	660	2000	950
Coating waste	250	250	250	250
High activity waste	700	410	1750	700
Self-concentration	500	360		470
Final vol. stored	200	50		230
Plus coating waste	250	0		250
Total waste stored	450	50		480

Allow under Budget Assumption for formation of an equilibrium self-concentrating heel by assuming 400 gal./TU high activity waste the first year. Assume that, after space reserved for jacket waste at C Farm is consumed, jacket wastes are tanked and 100 gallon boildown is achieved. This makes total waste tanked 380 gallons after 1957. Data on present consumption from E. R. Irish; on goal consumption from Lyle Zahn.

Assumed Schedule for Reaching Goal Waste Storage Consumption

<u>Calendar Year</u>	<u>Redox</u>	<u>Purex</u>
1956	1300	480
1957	700	480
1958	700	300
1959	450	250
1960	250	100
1961	250	50

The above assumptions were used as follows in constructing the curves:

For Curve C of Figure 2, the AEC estimate of available uranium and the extrapolation of this trend were used as the production basis. The Budget Assumption of waste stored per ton of uranium processed was used as the waste consumption basis. No Curve C was drawn for Figure 1 since it lay so close to Curve B as to be confusing.

For Curves A and B of both figures, the Pile Engineering estimate of actual uranium throughputs was used. As this is being written, it is anticipated that the Pile Engineering estimate is to be substituted for the assumptions in HW-39825, or the AEC estimate of available uranium. For Curve B, the conservative Budget Assumption figure was used for waste consumption per ton of uranium processed. For Curve A, the success of the R & D program in accordance with the tabulated schedule was assumed. In both figures, Curve B represents a conservative estimate of the actual rate of consumption of waste storage space. Curve A represents the most optimistic estimate of the rate of consumption. Curve B is a reasonable prediction and allows for some rework and the like, particularly since partial reclamation of the hydrostatic head reserve by the transfer of non-boiling superheats is allowable even if the reserve must be maintained for boiling wastes.

The construction contingency reserve and the hydrostatic head reserve are shown as bands parallel to Curve B. Similar bands parallel to Curve A are also implied, of course, but are not drawn, to avoid confusion. Also, since Curve A is optimistic, the waiving of the hydrostatic head limitation may be assumed.

The presently available waste storage tankage is shown by the heavy horizontal line. The location of new tankage is shown by a shaded block, 10,000,000 gallons high by 18 months wide. (It has been shown that construction of waste storage tankage in units of less than 10,000,000 gallons is uneconomical.) The proposed construction schedule is indicated by notes.

These charts illustrate graphically the following points:

1. The tankage available to Purex is so small in amount, and the range of waste consumption is so narrow until the middle of 1960, that a decision to construct 241-AX tankage at once is practically forced. If the forecast of Curve A were fully met, the existing 241-A tankage would suffice for about 14 years. But prudence demands provision of additional tankage for Purex, since the possibility is definite that this forecast cannot be completely met.
2. The tankage available to Redox is sufficiently large in amount, and the range of possible waste consumption rates is so wide starting in 1957, that postponement of construction of 241-SY is very attractive. If the forecast of Curve A is met, waste storage at Redox is sufficient for over 30 years. Even if this forecast is not fully met, many years of waste storage are available to Redox unless all of the pessimistic assumptions hold. A decision to construct 241-SY need not be considered until the fall of 1957, at the earliest. At that time the status of waste storage at Redox should again be reviewed, and advantage taken of any improvement in waste storage consumption achieved to that time to postpone this decision further. This policy should be continued, even to the extent of planning partial entry into T plant reserves if necessary, until a definite decision can be made on the Redox waste storage forecast.

Effect of Change in Goal Exposure

The goal exposure assumed in this study is 500 MWD/T. If this exposure is increased to 800 MWD/T, the uranium throughput will be reduced to such an extent that the Redox plant will be shut down. If, on the contrary, it is desired to reduce the goal exposure level, additional separations facilities will be required, and it is presumed that waste storage for these facilities would be provided. This change would also imply a greatly increased supply of uranium, which cannot be forthcoming until at least calendar year 1959. Thus it appears to be safe, for purpose of waste storage for the existing plants, to ignore major reductions in goal exposure, except for the possibility that the AEC may require a sharply reduced total quantity of low ng-s plutonium. If this change were made, and both Redox and Purex were running at full capacity on 200 MWD/T uranium, the reduced amount of self-concentration possible with the relatively low energy waste would necessitate a crash program or programs leading to both waste volume reduction and provision of additional waste storage capacity. Such a program, with maximum uranium handling but with reactors under sharply reduced power levels, appears most unlikely at present.

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APPENDIXSTATUS OF WASTE TANKS 1-1-56 AND ASSIGNMENT
(Capacities and Reserves in Thousands of Gallons)

<u>Tank</u>	<u>Capacity</u>	<u>Type Waste</u>	<u>Reserve</u>	<u>Assignment</u>	<u>Remarks</u>
<u>B FARM</u>					
101	530	Evap. Bots.	3	--	(1)
102	530	"	0		
103	554	"	0		
104	530	"	0		
105	530	"	14	--	(1)
106	519	TBP	312	B	Scavenging to reclaim 219
107	530	First cy. and Evap. Bots.	0		
108	530	"	4	--	(1)
109	527	"	33	B	
110	530	B Plant Cell drainage	79	B	Used as a cascade with overflow to crib
111	530	"	281	B	
112	542	"	0		To be scavenged
201	54.5	224	0		
202	54.5	"	0		
203	54.5	"	0		
204	54.5	"	0		
<u>C FARM</u>					
101	530	TBP	450	Purex	Scavenging to reclaim 246
102	530	TBP	400	Purex	Scavenging to reclaim 400
103	560	TBP	420	Purex	Scavenging to reclaim 420
104	530	TBP	425	Purex	Scavenging to reclaim 315
105	530	TBP	400	Purex	Scavenging to reclaim 416
106	519	TBP	377	Purex	Scavenging to reclaim 396
107	530	First cy & TBP	0		Mostly sludge
108	530	"	230	B	Scavenging to reclaim 230
109	521	"	461	B	Scavenging to reclaim 144
110	536	"	0		Half sludge
111	536	"	375	B	Scavenging to reclaim 375
112	530	"	300	B	Scavenging to reclaim 380
201	54.5	Hot semi	0		
202	54.5	"	48.5	Hot semi	
203	54.5	"	42.5	"	
204	54.5	"	42.5	"	

<u>Tank</u>	<u>Capacity</u>	<u>Type Waste</u>	<u>Reserve</u>	<u>Assignment</u>	<u>Remarks</u>
<u>EX FARM</u>					
101	530	Metal waste	530	B	
102	530	"	530	B	
103	530	"	530	B	
104	530	"	530	B	
105	530	"	470	U spill recovery	Temporary assignment; 530 reserve to B plant 1958
106	530	"	530	B	
107	530	First cy+TBP	0		mostly sludge
108	530	"	330	B	Scavenging to reclaim 330
109	519	TBP	0		Mostly sludge
110	530	Evap. Bots.	0		
111	530	"	0		
112	530	"	139	B	
<u>BY FARM</u>					
101	758	TBP	568	TBP	Scavenging to reclaim 560
102	758	TBP	578	TBP	Scavenging to reclaim 510
103	747	TBP	562	TBP	Scavenging to reclaim 551
104	758	TBP	680	TBP	
105	758	TBP	652	TBP	Scavenging to reclaim 265
106	758	TBP	482	TBP	Scavenging to reclaim 470
107	758	TBP	581	TBP	
108	758	TBP	638	TBP	
109	747	TBP	713	TBP	
110	758	TBP	0	TBP	Scavenge waste receiver
111	758	Metal waste	758	TBP	
112	747	"	747	TBP	
<u>T FARM</u>					
101	530	Metal waste	530	Redox	To be recovered
102	530	"	530	"	"
103	521	"	521	"	"
104	530	First cycle	0		Sludge
105	530	"	20	T	
106	519	"	509	T	
107	530	First cy + TBP	6	T	Mostly sludge
108	532	"	383	T	Scavenging to recover 383
109	543	"	407	T	Scavenging to recover 407
110	530	224	0	T	Cascade to cribs
111	530	224	65	T	"
112	530	224	399	T	"
201, 2, 3, 4	4 • 54.5	224	0		

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<u>Tank</u>	<u>Capacity</u>	<u>Type Waste</u>	<u>Reserve</u>	<u>Assignment</u>	<u>Remarks</u>
<u>U FARM</u>					
101	530	Metal waste	530	Redox	Recovery in progress
102	530	"	530	"	"
103	519	"	519	"	"
104	530	"	530	T	"
105	519	"	519	T	"
106	519	"	519	T	"
107	530	"	530	T	"
108	530	"	530	T	"
109	519	"	519	T	"
110	530	First cy Redox	46	Redox	
111	530	"	0		
112	514	"	0		
201	54.5	Redox	54.5	Redox	Available after recovery
202	54.5	"	54.5	"	operations complete
203	54.5	"	54.5	"	"
204	54.5	"	19.5	"	"
<u>TX FARM</u>					
101	758	Metal waste	758	Redox	Recovery in progress
102	758	"	758	"	"
103	758	TBP	570	"	Scavenging to reclaim 570
104	758	Metal waste	758	"	Recovery in progress
105	758	"	753	"	
106	758	"	752	"	
107	758	"	758	"	Recovery in progress
108	758	"	758	"	"
109	758	First cy TBP	0		Mostly sludge
110	758	"	560	Redox	Scavenging to reclaim 560
111	758	"	500	"	Scavenging to reclaim 500
112	752	Evap. Bots.	0		
113	758	"	5		(1)
114	758	"	19		(1)
115	747	Metal waste	747	Redox	To be recovered
116	758	Evap. Bots.	0		
117	758	"	35		(1)
118	747	"	677	Redox	
<u>TY FARM</u>					
101	758	First cycle	182	T	
102	758	First cy plus			
		Evap. bots.	0		
103	758	First cy	570	T	Scavenging to reclaim 570
104	758	TBP plus first cy	675	Redox	
105	758	TBP	450	T	Scavenging to reclaim 450
106	758	TBP	570	T	Scavenging to reclaim 570

<u>Tank</u>	<u>Capacity</u>	<u>Type Waste</u>	<u>Reserve</u>	<u>Assignment</u>	<u>Remarks</u>
<u>S FARM</u>					
101	758	Redox	13		(1)
102	758	"	0		
103	752	"	0		
104	758	"	0		
105	758	"	35	Redox	
106	754	"	0		
107	758	"	17	Redox	
108	758	"	0		
109	747	"	0		
110	758	"	0		
111	758	"	0		
112	747	"	0		
<u>SX FARM</u>					
101	1000	Redox	215	Redox	Boiling-to be returned to hydrostatic head limit
102	1000	"	17	"	
103	980	"	37	"	
104	1000	"	99	"	Boiling-to be returned to hydrostatic head limit
105	1000	"	37	"	
106	980	"	793	"	Condensate coll. tank (reserve)
107	1000	"	1000	"	Hydrostatic head limit
108	1000	"	436	"	
109	980	"	318	"	
110	1000	"	1000	"	Hydrostatic head limit
111	1000	"	1000	"	"
112	980	"	980	"	"
113	1000	"	1000	"	"
114	1000	"	1000	"	"
115	980	"	980	"	"
<u>A FARM</u>					
101	1000	Purex	1000	Purex	Hydrostatic head limit
102	1000	"	1000	"	"
103	1000	"	1000	"	"
104	1000	"	1000	"	"
105	1000	"	1000	"	"
106	1000	"	1000	"	"
Totals:					
B Plant			5270		
T Plant			6706		
TBP Plant			6959		
Redox			21377		
Purex			6472		

Note (1): Reserves of small gallonage cannot economically be used because of the cost of jumper changes. This does not apply where jumpers are now connected, or in SX Farm, where a valved jumper installation has been made.

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FIG. 1

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PUREX STORED WASTE PROGRAM

FIG.2

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REDOX STORED WASTE PROGRAM

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