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INVENTORY
RADIOACTIVE LIQUID WASTE TO GROUND
200 AREAS - 1945-1959

By

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INVENTORY
RADIOACTIVE LIQUID WASTE TO GROUND
200 AREAS - 1945-1959

INTRODUCTION

Since startup in January 1945 through December 1959, 4×10^9 gallons of radioactive liquid wastes have been discharged to cribs and trenches at HAPO by the Chemical Processing Department facilities in the 200 Areas. These wastes contained approximately 2.5×10^6 curies of beta emitters.⁽¹⁻²³⁾ The waste sources listed below, for which some isotopic analyses are available, contributed about 98% of this total.

Scavenged Waste Recovery Program-	- - - - -	54%
Redox Plant D-1 and D-2 Wastes-	- - - - -	39%
"B" and "T" Plants 2nd Cycle, 5-6 and 224 Wastes-	- - - - -	4%
Purex Plant "A" Tank Farm Condensate and Process Wastes	- - - - -	0.8%
221-U Concentrator Condensates-	- - - - -	0.2%

The Scavenged Waste Recovery Program was completed in 1957 and Redox Plant process changes were made during the latter part of 1958. These changes resulted in a significant reduction in the amount of radioactive materials that have been discharged to the ground in subsequent years, from a maximum of 8.2×10^5 curies in 1955 to 9×10^3 curies in 1959.

Although these large amounts of radioactive materials have been discharged to the ground, periodic waste report inventories include no reduction due to radioactive decay. The estimated depletion by radioactive decay is the basis of this report.

SUMMARY

Of the approximate 2.5×10^6 curies of beta emitters discharged to the ground in liquid wastes at HAPO Chemical Processing Department facilities in the 200 Areas from January 1945 through December 1959, only an estimated 11.2% (2.8×10^5 curies)

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of this amount remains at the end of 1959. Included in the estimate are 4.8×10^4 curies of Cs^{137} , 2.96×10^4 curies of Sr^{90} , and 3.2×10^2 curies of Co^{60} .

DISCUSSION

The number of curies of beta emitters and the more significant isotopes that were discharged to the ground each year were estimated from data that are contained in summary waste reports⁽¹⁻²³⁾ and from special analyses made on some of the waste streams.⁽²⁴⁾

The Scavenged Waste Recovery Program (1954-1957) contributed about 54% of the total radioactive materials that have been discharged to the ground. Analyses for Cs^{137} , Sr^{90} , Ru^{106} , Sb^{125} , Ce^{144} , and Zr-Nb^{95} were made on each tankful of these wastes. Analyses for Co^{60} were made during 1956 and 1957 and the average results from these analyses were assumed to be typical of the Co^{60} content in the wastes that were discharged prior to 1956.

Redox D-2 and D-1 Wastes (1952-1959), predominately D-2 waste, have contributed approximately 39% of the total activity. Limited isotopic analyses were performed on these wastes prior to July 1956. Cs^{137} , Sr^{90} , and Co^{60} analyses have been made on monthly composite samples since this time and the average results for 1956 were assumed to be representative of the wastes that were discharged to the ground before July 1956. Ru^{106} , a principal part of the D-2 waste activity, has been greatly reduced following re-routing of Redox H-4 oxidizer overheads in the latter part of 1958.

"B" and "T" Plant Wastes (1945-1953) accounted for approximately 4% of the waste activity. Two analyses performed on 224 - 2nd Cycle and 5-6 wastes⁽⁴⁾, were assumed to be representative of all wastes from these sources.

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Purex Plant Wastes (1957-1959), process condensates and "A" Tank Farm cooling water, have contributed approximately 0.8%. Estimates on these wastes are based on four isotopic analyses.

221-U Plant Concentrator Condensates (1952-1957) contributed about 0.2%. One isotopic analyses was assumed to be typical of all wastes from this source.

The estimated number of curies of isotopes that have been discharged to the ground each year through 1959 are summarized in Table 1.

TABLE 1
ESTIMATED CURIES OF RADIOACTIVE MATERIAL
DISCHARGED TO GROUND EACH YEAR
(Curies)

Year Dis- charged	Cs ¹³⁷	Sr ⁹⁰	Ru ¹⁰⁶	Sb ¹²⁵	Ce ¹⁴⁴	Zr-Nb ⁹⁵	Co ⁶⁰	Remaining Beta Fraction*
1945	495	5	100					80
1946	1,080	11	350		50			35
1947	1,550	16	780		40	20	1	275
1948	831	8	540		400		1	140
1949	861	9	1,800		168		3	558
1950	861	9	3,200		130		6	2,560
1951	912	9	1,600		283		5	1,804
1952	984	168	3,600		560		2	180
1953	998	560	18,680		100		61	9,470
1954	24,100	9,233	128,580	1,280		44,140	85	20,526
1955	4,580	11,873	258,900	16,500	3,230	17,040	200	68,580
1956	7,540	6,124	260,050	19,030	35,780	8,700	183	134,530
1957	6,873	3,973	82,030	8,640	32,290	926	63	121,620
1958	1,516	988	51,000	400	3,370	500	1	19,750
1959	1,190	98	2,110		30	517		2,690

* Curies of beta emitters not accounted for by the activity of the isotopes and their equilibrium daughters.

To simplify calculations, all wastes were assumed to have been discharged at the middle of the year. Exponential decay was calculated for each isotope to the end of each succeeding year and the computed values for Sr⁹⁰, Ce¹⁴⁴, and Ru¹⁰⁶

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were doubled to account for the activity of their equilibrium daughters. Work by Honstead⁽⁴⁾ indicated an apparent half-life of 200 days for "aged" bismuth phosphate wastes. Since wastes from the other sources could reasonably be expected to exhibit a half-life of less than 200 days, this half-life was used for decay calculation of the residual beta fraction.

The Curies of Beta Emitters that have been discharged to ground each year and the estimated amount remaining at the end of each year are summarized in Table II and Figure 1.

TABLE II

ESTIMATED CURIES OF BETA EMITTERS DISCHARGED
TO GROUND AND REMAINING EACH YEAR

<u>Year</u>	<u>Curies</u>	<u>Cumulative Curies</u>	<u>Curies Remaining*</u>
1945	884		767
1946	1,916	2,800	2,422
1947	4,237	7,037	5,375
1948	2,400	9,437	5,667
1949	5,600	15,037	8,667
1950	10,404	25,441	13,093
1951	7,059	32,500	14,111
1952	8,900	41,400	16,187
1953	48,950	90,350	44,961
1954	372,117	462,467	289,737
1955	821,007	1,283,474	698,203
1956	767,003	2,050,477	879,927
1957	316,875	2,367,352	668,674
1958	126,205	2,493,557	457,207
1959	8,792	2,502,349	283,301
		(2.5×10^6 *)	(2.8×10^5 *)

* Although computed values are tabled, no more than two significant values are assumed justified.

The Estimated Curies of Cs¹³⁷ that have been discharged to the ground and the amount remaining at the end of each year are summarized in Table III and Figure 2.

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TABLE III

ESTIMATED CURIES OF Cs¹³⁷ DISCHARGED TO GROUND
AND REMAINING EACH YEAR (30 YEAR HALF-LIFE)

<u>Year</u>	<u>Curies of Cs¹³⁷ Discharged</u>	<u>Cumulative Curies Cs¹³⁷ to Ground</u>	<u>Cumulative Curies Cs¹³⁷ Corrected for Decay</u>
1945	495*	495	489
1946	1,080*	1,575	1,545
1947	1,550*	3,125	3,040
1948	831*	3,956	3,791
1949	861*	4,817	4,554
1950	861*	5,678	5,298
1951	912*	6,590	6,077
1952	984*	7,574	6,908
1953	998	8,572	7,736
1954	24,100	32,672	31,368
1955	4,580	37,252	35,093
1956	7,540	44,792	41,736
1957	6,873	51,665	47,566
1958	1,516	53,181	47,979
1959	1,190	54,371	48,055
		(55,000)**	(48,000)**

* HW-47855, K. R. Heid - "Estimated Curies of Long-Lived Beta Particle Emitters Discharged to Ground at HAPO Through December 1956".

** Although computed values are tabled, no more than two significant figures are assumed justified.

The Estimated Curies of Sr⁹⁰ that have been discharged to ground and the amount remaining at the end of each year are summarized in Table IV and Figure 3.

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TABLE IVESTIMATED CURIES OF Sr^{90} DISCHARGED
TO GROUND AND REMAINING EACH YEAR

<u>Year</u>	<u>Curies of Sr^{90} Discharged</u>	<u>Cumulative Curies Sr^{90} to Ground</u>	<u>Cumulative Curies Sr^{90} Corrected for Decay</u>
1945	5*	5	4.9
1946	11*	16	9.7
1947	16*	32	21.4
1948	8*	40	28.8
1949	9*	49	36.9
1950	9*	58	44.9
1951	9*	67	52.8
1952	168*	235	218
1953	560*	795	765
1954	9,233*	10,028	9,858
1955	11,873*	21,901	21,331
1956	6,124*	28,025	26,842
1957	3,973	31,998	30,092
1958	988	32,986	30,314
1959	98	33,083	29,653
		(33,000)**	(29,500)**

* HW-47855, K. R. Heid - "Estimated Curies of Long-Lived Beta Particle Emitters Discharged to Ground at HAPD Through December 1956".

** Although computed values are tabled, no more than two significant figures are assumed justified.

An Estimated 620 Curies of Co^{60} have been discharged to ground through 1959. The bulk of this material was contained in the scavenged wastes. Since completion of the Scavenged Waste Recovery Program in 1957 negligible amounts have been discharged. Approximately 320 curies remained at the end of 1959.

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