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BIOPHYSICS SECTION

RADIOLOGICAL SCIENCES DEPARTMENT

RADIOACTIVE CONTAMINATION IN THE HANFORD ENVIRONS

FOR THE PERIOD

APRIL, MAY, JUNE

1954

November 4, 1954

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION

RICHLAND, WASHINGTON

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HW-33896

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RADIOACTIVE CONTAMINATION IN THE HANFORD ENVIRONS FOR THE PERIOD APRIL, MAY, JUNE 1954

By

H. J. Paas and G. E. Pilcher

November 24, 1954

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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ABSTRACT

SECTION I: RADIOACTIVE CONTAMINATION IN EFFLUENT GASES

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Average I^{131} emission from separation facilities was less than 1.3 curies/day during the quarter. Maximum emission was 15 curies/day from the S-plant stack. Ruthenium emission averaged less than 0.69 curie/day with the maximum 5.3 curies/day. Tritium oxide emitted from the 6 reactor stacks averaged 1.1 curies/day; maximum emission was measured at 105-C stack where 1.1 curies were emitted in a 24 hour period. S^{35} discharge from the 105-F reactor increased significantly; average daily emission was 1.5×10^{-2} compared to a previous 2.1×10^{-3} curie. Increases by factors ranging from 4 to 14 were noted in the number of radioactive particles emitted from reactor stacks.

SECTION II: RADIOACTIVE CONTAMINATION ON VEGETATION

Page 26

Increases in contamination deposited on vegetation were the result of fall-out during the month of June. Maximum measurements for I^{131} were found in and near the separation areas where an average of 3×10^{-5} μc/g included maximum measurements on the order of 2×10^{-4} μc/g. Trace I^{131} was found in the residential areas where the average was between 5 and 9×10^{-6} μc/g. Average I^{131} deposited at remote locations throughout the state was generally below 3×10^{-6} μc/g. Increases in the activity density of non-volatile beta particle emitters were also noted during June although many of the higher measurements appeared related to ground contamination in and near the 200-W area. Maximum measurements were found at the latter location where the average activity density was 6.5×10^{-3} μc/g and the maximum measurement was 0.3 μc/g. Alpha particle emission on vegetation returned to values on the order of magnitude expected for normal HAPO operation.

SECTION III: RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

Page 39

Dosage rates measured by Victoreen Integrons increased significantly at 200-W area and Redox to values ranging from 2.7 to 4.3 mrads/day. General increases in dosage rates at locations within a distance of 5 and 10 miles from the separations areas and near the 300 Area were measured by detachable ionization chambers. The activity density of filterable beta particle emitters in the atmosphere averaged between 2.2×10^{-13} μc/cc and 3.4×10^{-13} μc/cc at residential locations and between 6.2×10^{-13} μc/cc

and 9.0×10^{-12} μc/cc near the separations areas. The higher values noted during the period were due almost entirely to values measured during May, with a maximum weekly activity density of 3.6×10^{-11} μc/cc reported at Redox. General increases in radioactive particle concentrations in air were noted at nearly all sampling locations with the highest monthly average concentration of 1.7 particles/cubic meter occurring at Redox during May. The average concentrations measured at locations off-site ranged from 0.04 to 0.19 particles/cubic meter. As substantiated by radiochemical analyses of air filter and rain samples, the increased activity density of airborne beta particle emitters during May at remote locations was largely due to sources other than Hanford. Airborne I^{131} concentrations averaged less than 3×10^{-13} μc/cc in residential areas and averaged less than 6×10^{-13} μc/cc at locations near manufacturing areas.

SECTION IV: RADIOACTIVE CONTAMINATION IN HANFORD WASTES

Page 53

The activity density from gross beta particle emitters in effluent discharged to the Columbia River from reactor retention basins averaged between 5×10^{-3} and 6.3×10^{-3} μc/cc during the quarter; between 16,000 and 27,000 μc/second were discharged to the river from each area. Trace quantities of alpha particle emitters, plutonium, and polonium were found in isolated samples from the effluent basins in various areas. I^{131} discharged to the river from the Animal Farm averaged 30 μc/day. Large fluctuations noted in contamination measured in 200 and 300 Areas waste sources were consistent with previous observations. Ground contamination identified as ruthenium and rhodium daughters in and near the 200-W area gave instrument readings from several thousand c/m up to several hundred mrads/hr with negligible contamination being detected at the plant perimeter.

SECTION V: RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER AND RELATED WATERS

Page 63

Seasonal increases in the flow rate of the Columbia River caused decreased activity density of beta particle emitters in nearly all locations. Maximum measurements were found in the Hanford area where the average was 1.0×10^{-5} μc/cc including a maximum measurement of 3.6×10^{-5} μc/cc. Average values at Pasco and McNary Dam were 2.1×10^{-6} and 2.5×10^{-7} μc/cc, respectively. Trace beta particle emission was measured by a sample collected at Astoria, Oregon, during low tide in which the activity density was 1.2×10^{-8} μc/cc. No significant alpha particle emission was detected in Columbia River water. Velocity studies showed an average of 2.4 miles/hour over the 54 miles of river between 100-B Area and the Pasco Filter Plant with a river flow of 800,000 gal/sec. Radioactive con-

[redacted]

tamination measured in mud samples remained on the orders of magnitude previously noted. Decreases in the activity density of beta particle emitters in raw water were associated with the increased flow of the river. Maximum measurements on the order of 3×10^{-6} μc/cc were found near the 100-F Area during the early part of the quarter.

SECTION VI: RADIOACTIVE CONTAMINATION IN RAIN Page 71

The activity density of beta particle emitters in rain samples increased significantly during the middle of the quarter when measurements were apparently influenced by nuclear detonation debris. Samples collected from residential areas showed values ranging from 8×10^{-5} to 2.4×10^{-4} μc/cc whereas samples collected near the separation areas ranged from 2×10^{-5} μc/cc to 8×10^{-4} μc/cc. Excluding the May measurements, maximum measurements found during this period were 5 to 10 times greater than those observed during the previous quarter.

SECTION VII: RADIOACTIVE CONTAMINATION IN DRINKING WATER SUPPLIES AND TEST WELLS Page 74

Alpha particle emission exceeded an average of 5×10^{-9} μc/cc at five Richland wells, two Benton City wells, and at Enterprise. Mean values for Richland were 6×10^{-9} μc/cc and at the other locations ranged from 1.2 to 1.5×10^{-8} μc/cc. Trace uranium was found in each of these wells at some time during the period. Average values for beta particle emitters in water consumed at Pasco and Kennewick were 2×10^{-7} and 1.8×10^{-7} μc/cc, respectively. Maximum measurements were 4×10^{-7} μc/cc. Beta particle emission was also detected in sanitary water supplies at the reactor areas. Seasonal decreases were noted in measurements obtained from samples collected at the Pasco Filter Plant and were in close agreement with expected changes based on the flow rate of the Columbia River.

[redacted]

INTRODUCTION

This publication summarizes the results obtained from monitoring the HAPO environs for radioactive contamination during the period April, May, and June, 1954. Samples were collected by Regional Survey forces according to procedures previously outlined in documents of this series (HW-30174, HW-31818, and HW-29514). These samples were analyzed by the Control Laboratory of the Control Unit according to procedures and techniques described in HW-20136. Counting rates obtained from these analyses were corrected for geometry, back-scatter, air-window absorption, source size, self-absorption, chemical yield, and collection efficiency by the Control Services group using factors shown in HW-22682, HW-23769, HW-27854, and HW-30492. Additional corrections for decay were applied to those samples in which significant amounts of short half-life beta particle emitters were found. The findings obtained from analyzing the direct samples were supplemented with readings obtained from portable and fixed instrumentation. Over 20,000 individual measurements were compiled for use in this document.

The results obtained from this study are presented in Sections I through VII which discuss the amounts of contamination discharged from plant facilities, and their effect on the contamination of vegetation, air, soil, and water.

SECTION I

RADIOACTIVE CONTAMINATION IN EFFLUENT GASES

Samples of effluent gases were collected from HAPO reactor and separation area stacks at frequencies ranging from daily to weekly. I^{131} and ruthenium analyses were performed on the continuous scrubber and filter samples operated at the separation area stacks; gases entering and leaving the Redox sand filter were monitored by collecting daily filter samples. Activity from several emitters, including C^{14}, S^{35}, tritium oxide and radioactive particles was measured in the reactor area stack gases. Summaries of the results for each manufacturing area are presented.

SEPARATION AREAS

200 EAST AREA

Table I is a summary of the weekly filter measurements obtained at the Semi-Works stack. The extended shut-down of this facility was continued through the present quarter, and was responsible for the continued low activity density of gross beta particle emitters in these effluents.

TABLE I

SUMMARY OF RESULTS FROM STACK MONITORING

SEMI-WORKS STACK

APRIL, MAY, JUNE

1954

Month	Curie of Gross Beta Particle Emitters Emitted Daily	
	Maximum	Average
April	3.2×10^{-5}	8.1×10^{-6}
May	4.7×10^{-6}	2.7×10^{-6}
June	1.3×10^{-5}	4.9×10^{-6}
Quarter	3.2×10^{-5}	5.4×10^{-6}
Last Quarter	6.5×10^{-3}	9.1×10^{-5}

200 WEST AREA T-PLANT

The results obtained from monitoring at the fifty-foot level of the T-plant stack are summarized in Table II.

TABLE II

SUMMARY OF RESULTS FROM I^{131} MONITORING

T-PLANT STACK

APRIL, MAY, JUNE

1954

Month	Curie of I^{131} Emitted Daily	
	Maximum	Average
April	2.2	9.6×10^{-2}
May	2.2	0.42
June	1.7	0.30
Quarter	2.2	0.26
Last Quarter	0.60	8.9×10^{-2}

[redacted]

The increase in I^{131} emission for this stack noted during the present quarter was due to an increased production schedule with more dissolving runs of longer cooling period metal being made at T-plant this quarter than during the previous quarter. The faster dissolving schedule was responsible for the release of a higher percentage of the I^{131} present in the dissolvers. An average of 100 curies of I^{131} per day was available in the metal dissolved compared to 130 curies per day during the previous quarter.

200 WEST AREA S-PLANT

A summary of the results obtained from monitoring for I^{131} at the S-plant stack is presented in Table III.

TABLE III

SUMMARY OF RESULTS FROM I^{131} MONITORING

S-PLANT STACK

APRIL, MAY, JUNE

1954

Month	Curies of I^{131} Emitted Daily	
	Maximum	Average
April	15	1.8
May	3.5	1.0
June	0.91	<0.24
Quarter	15	<1.0
Last Quarter	11	1.6

[redacted]

Average and maximum I^{131} emission values compare favorably with those noted during the previous quarter. Lower cooling periods this quarter resulted in an increased amount of I^{131} being available in the dissolved metal but a lower percentage of this I^{131} was emitted from the stacks. I^{131} available in the metal dissolved averaged 250 curies per day this quarter compared to 110 curies per day during last quarter.

Table IV summarizes the results obtained from monitoring for ruthenium at the S-plant stack.

TABLE IV

SUMMARY OF RESULTS FROM RUTHENIUM MONITORING

S-PLANT STACK

APRIL, MAY, JUNE

1954

Ruthenium Emission

Units of Curies Per Day

Month	Filter Collection		Scrubber Collection		Total	
	Maximum	Average	Maximum	Average	Maximum	Average
April	5.2	0.86	0.59	0.09	5.3	0.94
May	2.2	0.54	0.23	0.03	2.3	0.56
June	3.2	<0.54	0.10	0.02	3.2	<0.54
Quarter	5.2	<0.65	0.59	0.06	5.3	<0.69
Last Quarter	210	3.9	130	2.3	230	6.3

The figures reported in Table IV are based on measurements made at a point 20 feet above the base of the stack and do not include any contributions of material sluffing off from the upper stack liner into the effluent. Ruthenium emission during the quarter from the S-plant stack, based on such measurements, compared favorably with that noted from similar measurements during the fourth quarter of 1953. The average values for the first quarter of 1954 were weighted by the unusually high

[redacted]

emission of over 300 curies during a short period in January and could not be compared with those of the present quarter.

The extended shutdown of the S-plant during the latter part of June contributed to lowered emission of both I^{131} and ruthenium during the latter part of the quarter. Revisions were made during this shutdown to route more of the process effluent gases through the sand filter in order to reduce emission of ruthenium from the stack.

Results of 37 measurements of the activity density of rare earths and yttrium in the S-plant stack gases revealed that an average of 0.23 curie per day of these emitters was emitted on the days they were measured with insignificant activities at all other times; a maximum measurement of 0.91 curie per day was obtained on May 25. Average and maximum values for the previous quarter were 0.1 and 0.3 curie per day, respectively. Spot measurements of the activity density of zirconium and strontium were maintained during the quarter; maximum measurements were below 0.1 curie per day for these two emitters.

A summary of the results obtained from daily filter measurements at the inlet to the Redox sand filter is presented in Table V.

TABLE V

SUMMARY OF FILTER MEASUREMENTS

S-PLANT SAND FILTER INLET

APRIL, MAY, JUNE

1954

Gross Beta Particle Emitters

	Units of 10^{-3} $\mu c/ft^3$		Units of Curies/Day into Sand Filter	
Month	Maximum	Average	Maximum	Average
April	>200	>30	>9.9	>1.7
May	1490	490	86	28
June	260	28	15	1.6
Quarter	1490	>180	86	>10
Last Quarter	5600	83	320	4.8

[redacted]

These measurements were obtained by drawing an aliquot of the incoming gases through a CWS filter paper and then reading the dosage rates on the filters with a CP meter. The dosage rates were converted to micro-curies per filter by applying the factor of 50 mrad/hr/μc found by monitoring and then analyzing a large number of these filters during the past two quarters. The average values obtained this quarter (Table V) are higher than those found during the previous quarter even though the one high value obtained during March is included in the previous quarterly average. The most significant increase was noted during May when the average activity density of the gases entering the sand filter was 0.49 $\mu c/ft^3$.

Specific analyses were performed on two filters removed in March and May. The composition of the activity on the filter removed on March 9 was 92 percent ruthenium, 2.9 percent rare earths, and 1.4 percent zirconium; total beta activity was 550 μc/filter. Composition of radioactive material on the filter removed on May 18 was 24 percent ruthenium, 28 percent rare earths, 8 percent strontium, 14 percent zirconium, and 25 percent niobium (assuming equilibrium between zirconium and niobium daughter); total beta activity was 1100 μc/filter.

Samples of the gases leaving the Redox sand filter were collected similarly to the inlet gas samples. The filters were counted on a proportional counter and then autoradiographed for 168 hours. The counting measurements initiated during May were converted to curies of gross beta particle emitters leaving the sand filter per day. The results of these calculations and of the autoradiographs are summarized in Table VI.

TABLE VI

SUMMARY OF FILTER MEASUREMENTS

S-PLANT SAND FILTER OUTLET

APRIL, MAY, JUNE

1954

	Radioactive Particles Units of 10^5 ptles/day		Gross Beta Particle Emitters Units of 10^{-3} curie/day	
Month	Maximum	Average	Maximum	Average
April	4.2	1.3	—	—
May	1000	67	1.1	0.16
June	1300	140	0.78	0.29
Quarter	1300	57	1.1	0.25
Last Quarter	580	14	—	—

The average number of particles per day leaving the sand filter during April was comparable to the average value for January, 1954. Monthly averages for the previous quarter were 1.4×10^5, 4.7×10^5, and greater than 4.2×10^6 particles/day in January, February, and March, respectively.

200 WEST AREA U-PLANT

Table VII is a summary of the results obtained from filter monitoring at the U-plant stack.

TABLE VII

SUMMARY OF FILTER MEASUREMENTS

U-PLANT STACK

APRIL, MAY, JUNE

1954

Curies Emitted Per Day

	Gross Alpha Particle Emitters		Gross Beta Particle Emitters		Radioactive Particles	
	Units of 10^{-8} curie		Units of 10^{-5} curie		Units of 10^{4} particles/day	
Month	Maximum	Average	Maximum	Average	Maximum	Average
April	2.3	0.19	16	8.0	3.5	1.4
May	1.4	0.56	45	11	6.0	2.7
June	1.8	0.87	21	2.8	17	10
Quarter	2.3	0.53	45	7.3	17	3.5
Last Quarter	7.2	1.5	7.3	1.9	26	5.0

The average activity density of gross beta particle emitters in gases emitted from the U-plant stack was higher by a factor of four during the present quarter than during the last quarter; average alpha particle emitter activity density decreased this quarter to one-third of the previous quarter's average. Neither of these changes was out of the range of fluctuation previously noted for this location. The maximum measurement of 4.5×10^{-4} curie of gross beta particle emitters per day was obtained on the filter operated from April 27 to April 29.

There was no significant difference in the average radioactive particle concentration for this quarter compared with the average for the previous quarter (Table VII). The increase in activity density of gross beta particle emitters collected on a filter without a corresponding increase in the concentration of radioactive particles indicates an increase in the specific activity of the individual particles.

REACTOR AREAS

The results of the analysis of samples of the reactor areas stack gases for C^{14}, S^{35}, tritium oxide, gross alpha and gross beta particle emitters retained on filters, and radioactive particles are summarized in Tables VIII through XIII.

TABLE VIII

SUMMARY OF STACK MONITORING RESULTS

105-B STACK

APRIL, MAY, JUNE

1954

Curies Emitted Per Day

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Particle Emitters Measured on Air Filters: Total Alpha Units of 10^{-7}	Total Beta Units of 10^{-5}	Radioactive Particles Units of 10^{5} particles/day
April						
Maximum	0.26	<4.5	6.7	4.0	130	4.2
Average	0.13	<4.5	<4.5	2.0	100	1.5
May						
Maximum	1.0	<4.5	20	22	660	6.0
Average	0.35	<4.5	7.5	2.3	180	3.4
June						
Maximum	0.19	<4.5	5.6	0.59	160	2.9
Average	0.14	<4.5	5.6	0.47	59	0.5
Quarter						
Maximum	1.0	<4.5	20	22	660	6.0
Average	0.22	<4.5	5.6	1.9	130	2.0
Last Quarter						
Maximum	0.81	<4.5	22	4.0	250	0.86
Average	0.22	<4.5	4.6	1.4	140	0.39

TABLE IX

SUMMARY OF STACK MONITORING RESULTS

105-C STACK

APRIL, MAY, JUNE

1954

Curies Emitted Per Day

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Particle Emitters Measured on Air Filters: Total Alpha Units of 10^{-7}	Total Beta Units of 10^{-5}	Radioactive Particles Units of 10^{5} particles/day
April						
Maximum	0.26	5.2	21	11	260	65
Average	0.09	<4.5	14	4.2	83	28
May						
Maximum	0.28	<4.5	7.6	4.1	150	73
Average	0.07	<4.5	<4.5	2.5	68	>58
June						
Maximum	1.1	<4.5	<4.5	3.8	140	99
Average	0.18	<4.5	<4.5	0.38	43	70
Quarter						
Maximum	1.1	5.2	21	11	260	99
Average	0.10	<4.5	5.3	2.2	63	>52
Last Quarter						
Maximum	0.86	5.8	31	12	1800	26
Average	0.10	<4.5	8.6	2.4	240	12

TABLE X

SUMMARY OF STACK MONITORING RESULTS

105-D STACK

APRIL, MAY, JUNE

1954

Curies Emitted Per Day

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Particle Emitters Measured on Air Filters: Total Alpha Units of 10^{-7}	Total Beta Units of 10^{-5}	Radioactive Particles Units of 10^{5} particles/day
April						
Maximum	0.35	13	16	0.51	240	0.50
Average	0.22	<4.5	8.1	0.39	170	0.21
May						
Maximum	0.58	20	12	7.3	1200	7.3
Average	0.34	7.9	5.4	13	150	4.3
June						
Maximum	0.24	9.5	9.4	0.93	510	<3.0
Average	0.20	5.7	4.9	0.61	160	0.43
Quarter						
Maximum	0.58	20	16	7.3	1200	7.3
Average	0.27	6.0	6.1	0.84	160	1.8
Last Quarter						
Maximum	1.1	7.9	34	2.3	580	---
Average	0.26	<4.5	8.4	0.74	210	---

TABLE XI

SUMMARY OF STACK MONITORING RESULTS

105-DR STACK

APRIL, MAY, JUNE

1954

Curies Emitted Per Day

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Particle Emitters Measured on Air Filters: Total Alpha Units of 10^{-7}	Total Beta Units of 10^{-5}	Radioactive Particles Units of 10^{5} particles/day
April						
Maximum	0.23	<4.5	<4.5	1.1	0.98	<0.43
Average	0.08	<4.5	<4.5	0.66	0.71	0.09
May						
Maximum	0.17	8.9	32	1.1	2.0	4.4
Average	0.09	<4.5	15	1.1	0.83	1.8
June						
Maximum	0.48	<4.5	20	0.76	0.68	3.0
Average	0.22	<4.5	9.5	0.28	0.32	0.12
Quarter						
Maximum	0.48	8.9	32	1.1	2.0	4.4
Average	0.11	<4.5	10	0.66	0.61	0.67
Last Quarter						
Maximum	1.5	<4.5	45	2.3	2.0	<2.6
Average	0.12	<4.5	11	0.50	0.61	0.09

TABLE XII

SUMMARY OF STACK MONITORING RESULTS

105-F STACK

APRIL, MAY, JUNE

1954

Curies Emitted Per Day

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Particle Emitters Measured on Air Filters: Total Alpha Units of 10^{-7}	Particle Emitters Measured on Air Filters: Total Beta Units of 10^{-5}	Radioactive Particles Units of 10^{5} particles/day
April						
Maximum	0.47	<4.5	94	12	420	2.1
Average	0.18	<4.5	44	5.8	240	1.2
May						
Maximum	0.59	<4.5	900	130	3000	36
Average	0.19	<4.5	360	44	440	22
June						
Maximum	0.18	11	35	1.7	150	210
Average	0.07	<4.5	20	0.41	88	16
Quarter						
Maximum	0.59	11	900	130	3000	210
Average	0.17	<4.5	150	17	250	16
Last Quarter						
Maximum	2.5	6.2	84	9.3	780	---
Average	0.27	<4.5	21	2.9	190	---

TABLE XIII

SUMMARY OF STACK MONITORING RESULTS

105-H STACK

APRIL, MAY, JUNE

1954

Curies Emitted Per Day

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Particle Emitters Measured on Air Filters: Total Alpha Units of 10^{-7}	Particle Emitters Measured on Air Filters: Total Beta Units of 10^{-5}	Radioactive Particles Units of 10^{5} particles/day
April						
Maximum	0.20	5.5	5.7	1.7	5.9	12
Average	0.10	<4.5	<4.5	1.5	4.3	4.2
May						
Maximum	0.37	<4.5	6.2	6.1	89	>66
Average	0.18	<4.5	4.6	0.78	29	>22
June						
Maximum	0.21	<4.5	<4.5	4.6	29	44
Average	0.07	<4.5	<4.5	0.46	11	18
Quarter						
Maximum	0.37	5.5	6.2	6.1	89	>66
Average	0.13	<4.5	<4.5	1.2	15	>14
Last Quarter						
Maximum	0.62	<4.5	8.1	5.1	230	9.4
Average	0.13	<4.5	<4.5	1.7	22	0.95

Average tritium oxide emission from the six reactor area stacks totaled 1.0 curie/day compared to 1.1 curie/day during the previous quarter. The only noticeable change occurred at 100-F where the average daily emission was 0.17 curie/day this quarter compared to 0.27 curie/day during the previous quarter. Maximum tritium oxide emission this quarter was 1.1 curie/day on June 18 from the 105-C stack; maximum emission during the previous quarter was 2.5 curies/day from the 105-F stack.

One positive C^{14} measurement was obtained at each of the 105-C, 105-DR, 105-F, and 105-H stacks; these positive values did not represent any significant change from the previous quarter's measurements. A slight increase was noted in the C^{14} emission rate from the 105-D stack this quarter when six positive measurements were obtained. The maximum value of 2.0×10^{-2} curie/day was obtained on May 18.

The only significant change noted in the S^{35} emission this quarter was at the 105-F stack where the average daily emission increased by a factor of seven over the average value for the previous quarter. Eight positive S^{35} measurements, with a maximum of 9.0×10^{-2} curie/day on May 18, were obtained at this stack during the quarter; average emission was 1.5×10^{-2} curie/day. Maximum and average values for the previous quarter were 8.4×10^{-3} and 2.1×10^{-3} curie/day, respectively. The maximum value of 9.0×10^{-2} curie/day represents the highest daily S^{35} emission rate measured at any reactor area stack during 1954.

During May, the average activity density of gross alpha and gross beta particle emitters in the 105-F (Table XII) stack gases increased by factors of seven and two, respectively, over the average values for April. During June the averages decreased to values well below the April measurements. This same trend was noted in the S^{35} measurements. The average activity density of these two types of emitters showed no significant changes

[redacted]

at the 105-B, 105-DR, and 105-H stacks, although, as at 105-F, the maximum measurements were obtained during May. There was no significant change in the average activity density of gross alpha particle emitters in the 105-C stack gases; the average and maximum gross beta particle emitter activity density decreased from the high values noted during the previous quarter at this stack.

General increases were noted in the radioactive particle concentrations in reactor area stack gases this quarter. During the previous quarter the majority of the filters obtained from the 105-D and 105-F reactor stacks produced autoradiographs too dense to evaluate and no values were available for comparison. Magnitude of the increases ranged from a factor of four at 105-C to a factor of fourteen at 105-H. For almost all of the normally low activity density stack gases monitored, the quarterly maximum values occurred during the month of May. This general increase indicates a general increase in the airborne activity contained in the air drawn into the buildings for ventilation purposes rather than contribution from any one reactor.

[redacted]

SECTION II

RADIOACTIVE CONTAMINATION ON VEGETATION

The deposition of radioactive contamination in the HAPO environs was determined from the results obtained from radiochemical analyses of nearly 2500 vegetation samples. Over 1800 of these samples were collected from locations in the nearby environs and the remaining samples were obtained from remote locations in Eastern Washington, Southern Washington, and Northern Oregon. The samples were analyzed for the activity density from I^{131} and from non-volatile beta particle emitters; selected samples from several locations in the immediate environs were analyzed for the activity density of alpha particle emitters. Table I summarizes the results obtained from the beta particle measurements; average values representing the previous quarter are included for comparison.

TABLE I

RADIOACTIVE CONTAMINATION ON VEGETATION

APRIL, MAY, JUNE

1954

Location	I^{131} Units of 10^{-6} µc/g				Non-Volatile Emitters Units of 10^{-6} µc/g		
	No. Samples	Max.	Avg.	Last Qtr. Avg.	Max.	Avg.	Last Qtr. Avg.
North of 200 Areas	205	150	10	4	6700	600	1200
Near the 200 Areas	121	140	10	8	7900	750	12000
Route 3	5	11	5	18	22000	4600	490
200 West Gate	61	220	30	49	19000	630	560
200 East Tower #16	51	120	15	12	6000	430	78
Batch Plant	41	68	16	47	59000	3400	33000
Meteorology Tower	13	50	13	31	1400	340	160
South of 200 Areas	337	190	9	5	3300	300	56
Richland	169	96	6	4	2800	200	41
Pasco Environs	132	93	6	<3	3100	230	31
Kennewick Environs	168	120	6	<3	3400	220	29
Benton City-Kiona	39	25	4	<3	940	170	49
Richland "Y"	12	27	4	4	---	---	---
Hanford	13	18	5	6	---	---	---
200 East Area	45	180	34	9	3900	840	450
200 West Area	66	19	5	-	310000	6500	22000
Wahluke Slope	158	140	23	<3	3700	510	270
Goose Egg Hill	40	20	3	9	710	150	120
Rattlesnake Mt.	29	3	<3	12	220	85	52
PSN-300-310-330	39	120	12	4	4900	350	71
Redox Construction	88	---	--	55	25000	1200	14000
Off Area Sampling							
Pasco to Ringold	72	90	20	3	3700	620	50
Prosser to Patterson-McNary	193	43	3	<3	2600	170	32
Eastern Washington	200	11	<3	3	160	39	58
S. Washington and No. Oregon	189	12	<3	<3	580	52	26

[redacted]

A comparison of the average values shown in Table I with the results obtained during the previous quarter shows some fluctuation in the activity density of I^{131} and a general increase in that of non-volatile beta particle emitters during this period. This increase was largely the result of higher measurements obtained during the month of May when the deposition throughout the environs was influenced by fallout of particulate contamination from sources believed to be other than the HAPO operation. The significance of the increase during the month of May may be appraised by reviewing Figures 1 through 4 which show the estimated iso-activity deposition of I^{131} for each of the three months within the period along with the quarterly average deposition based on all measurements during this period. Tables II and II summarize the results on a month to month basis for the various beta particle emitters.

[redacted]

TABLE II

ACTIVITY DENSITY FROM I^{131} ON VEGETATION

APRIL, MAY, JUNE

1954

Units of 10^{-6} µc/g

Location	April		May		June	
	Max.	Avg.	Max.	Avg.	Max.	Avg.
North of 200 Areas	7	<3	150	25	12	<3
Near the 200 Areas	18	4	140	24	13	<3
Route 3	<3	<3	11	9	3	<3
200 West Gate	36	13	220	37	42	13
200 East Tower #16	27	8	120	31	8	4
Batch Plant	54	16	68	30	11	5
Meteorology Tower	15	9	50	21	16	7
South of 200 Areas	20	<3	190	21	8	<3
Richland	6	<3	96	15	10	<3
Pasco Environs	7	<3	93	17	5	<3
Kennewick Environs	5	<3	120	15	10	<3
Benton City - Kiona	3	<3	25	10	<3	<3
Richland "Y"	3	<3	27	10	8	<3
Hanford	5	<3	118	9	77	<3
200 East Area	14	6	180	85	6	<3
200 West Area	--	--	9	4	19	6
Wahluke Slope	12	<3	140	43	6	<3
Goose Egg Hill	20	8	---	--	6	<3
Rattlesnake Mountain	3	<3	---	--	3	<3
PSN-300-310-330	11	<3	120	27	6	<3
Redox Construction	--	--	---	--	--	--
Off Area Sampling						
Pasco to Ringold	9	<3	93	44	9	<3
Prosser to Patterson-McNary	5	<3	43	10	7	<3
Eastern Washington	<3	<3	11	<3	4	<3
So. Washington and No. Oregon	5	<3	5	<3	12	<3

[redacted]

TABLE III

ACTIVITY DENSITY FROM NON-VOLATILE BETA PARTICLE EMITTERS ON VEGETATION

APRIL, MAY, JUNE

1954

Units of 10^{-6} μc/g

Location	April		May		June	
	Max.	Avg.	Max.	Avg.	Max.	Avg.
North of 200 Areas	6700	780	5700	830	240	110
Near the 200 Areas	4200	290	7900	1800	550	180
Route 3	22000	22000	680	680	76	62
200 West Gate	19000	1000	3000	710	270	110
200 East Tower #16	120	42	6000	1100	360	140
Batch Plant	59000	5400	22000	3400	2300	500
Meteorology Tower	1000	310	1400	520	280	140
South of 200 Areas	150	45	3300	780	390	140
Richland	180	37	2800	500	370	85
Pasco Environs	60	30	3100	570	250	93
Kennewick Environs	200	39	3400	550	270	34
Benton City - Kiona	44	27	940	350	110	62
Richland "Y"	---	---	---	---	---	---
200 East Area	73	43	2900	2300	340	150
200 West Area	310000	18000	13000	1100	2100	340
Wahluke Slope	480	70	3700	1400	350	32
Goose Egg Hill	82	40	---	---	710	250
Rattlesnake Mountain	46	34	---	---	220	100
PSN-300-310-330	160	49	4900	770	250	140
Redox Construction	7500	950	25000	2500	1700	210
Off Area Sampling						
Pasco to Ringold	100	43	3700	1700	350	90
Prosser to Patterson-McNary	120	43	2600	450	220	90
Eastern Washington	110	35	170	43	140	39
So. Washington and No. Oregon	55	27	220	42	600	90

Average values based on all measurements obtained during the quarter show that the mean deposition of I^{131} was 1.1×10^{-5} μc/g in the HAPO environs. In residential areas surrounding the plant perimeter, the average deposition was 5×10^{-6} μc/g. Maximum measurements on the order of 1×10^{-4} μc/g in residential areas were found on May 10 and May 11 when the results obtained from the atmospheric monitoring program showed significant increases in the number of airborne radioactive particles. (Section III).

A large number of the maximum non-volatile beta particle measurements were also noted around May 11 although a number of higher values which were apparently influenced by extensive ground contamination near the 200-W Area were observed during other periods of the quarter.

Table IV summarizes the results obtained from the analysis of vegetation samples collected from remote communities.

TABLE IV

RADIOACTIVE CONTAMINATION ON VEGETATION

OFF-AREA LOCATIONS

APRIL, MAY, JUNE

1954

Units of 10^{-6} μc/g

Location	I^{131} No. Samples	I^{131} Max.	I^{131} Avg.	Non-Volatile Beta Emitters No. Samples	Non-Volatile Beta Emitters Max.	Non-Volatile Beta Emitters Avg.
Moxee	8	<3	<3	12	250	45
Union Gap	5	7	<3	6	120	32
Wapato	8	<3	<3	12	55	30
Toppenish	8	5	<3	12	49	26
Toppenish to Goldendale	10	9	<3	16	360	56
Goldendale	8	5	<3	12	80	30
Goldendale to Wishram	2	8	5	5	190	54
Lyle	4	<3	<3	6	88	36
Bingen	4	<3	<3	6	76	50
Camas	8	3	<3	12	74	34
Vancouver	8	<3	<3	12	95	49
Portland	8	<3	<3	12	110	54
Troutdale	4	<3	<3	6	100	47
Bonneville	4	<3	<3	6	63	29
Hood River	4	6	<3	6	92	40
The Dalles	8	8	<3	12	580	73
Moody	3	<3	<3	6	270	59
Rufus	4	12	4	6	590	140
Blalock	4	5	<3	6	260	110
Arlington	4	6	4	6	240	90
Heppner Junction	4	5	<3	6	100	70
Boardman	5	<3	<3	6	160	70
Wallula	4	5	<3	6	140	62
Touchet	4	<3	<3	6	36	28
Lowden	4	<3	<3	6	44	25
Walla Walla	7	<3	<3	12	58	32
Dixie	4	<3	<3	6	58	23
Waitsburg	8	<3	<3	11	130	37
Dayton	8	<3	<3	12	110	36
Pomeroy	8	4	<3	12	96	41
Lewiston	8	<3	<3	12	75	31
Uniontown	4	<3	<3	6	56	35
Pullman	8	<3	<3	12	72	32

TABLE IV (contd.)

Units of 10^{-6} μc/g

Location	I^{131} No. Samples	I^{131} Max.	I^{131} Avg.	Non-Volatile Beta Emitters No. Samples	Non-Volatile Beta Emitters Max.	Non-Volatile Beta Emitters Avg.
Colfax	4	<3	<3	6	62	33
Steptoe	4	<3	<3	6	28	21
Rosalia	4	3	<3	6	87	62
Spangle	4	<3	<3	6	69	37
Spokane	8	<3	<3	12	120	38
Cheney	4	<3	<3	8	82	44
Sprague	8	11	<3	12	160	58
Ritzville	8	<3	<3	12	95	37
Lind	8	4	<3	12	90	32
Connell	8	<3	<3	12	130	64
Eltopia	1	<3	<3	1	81	81
Reardon	2	<3	<3	2	44	34
Davenport	2	<3	<3	2	69	41
Harrington	2	<3	<3	2	24	23

The values summarized in Table IV were not significantly different from those noted in the same locations during the previous quarter.

Table V summarizes the results obtained from analyzing samples for the activity density of alpha particle emitters.

TABLE V

ACTIVITY DENSITY OF GROSS ALPHA PARTICLE EMITTERS

ON VEGETATION

APRIL, MAY, JUNE

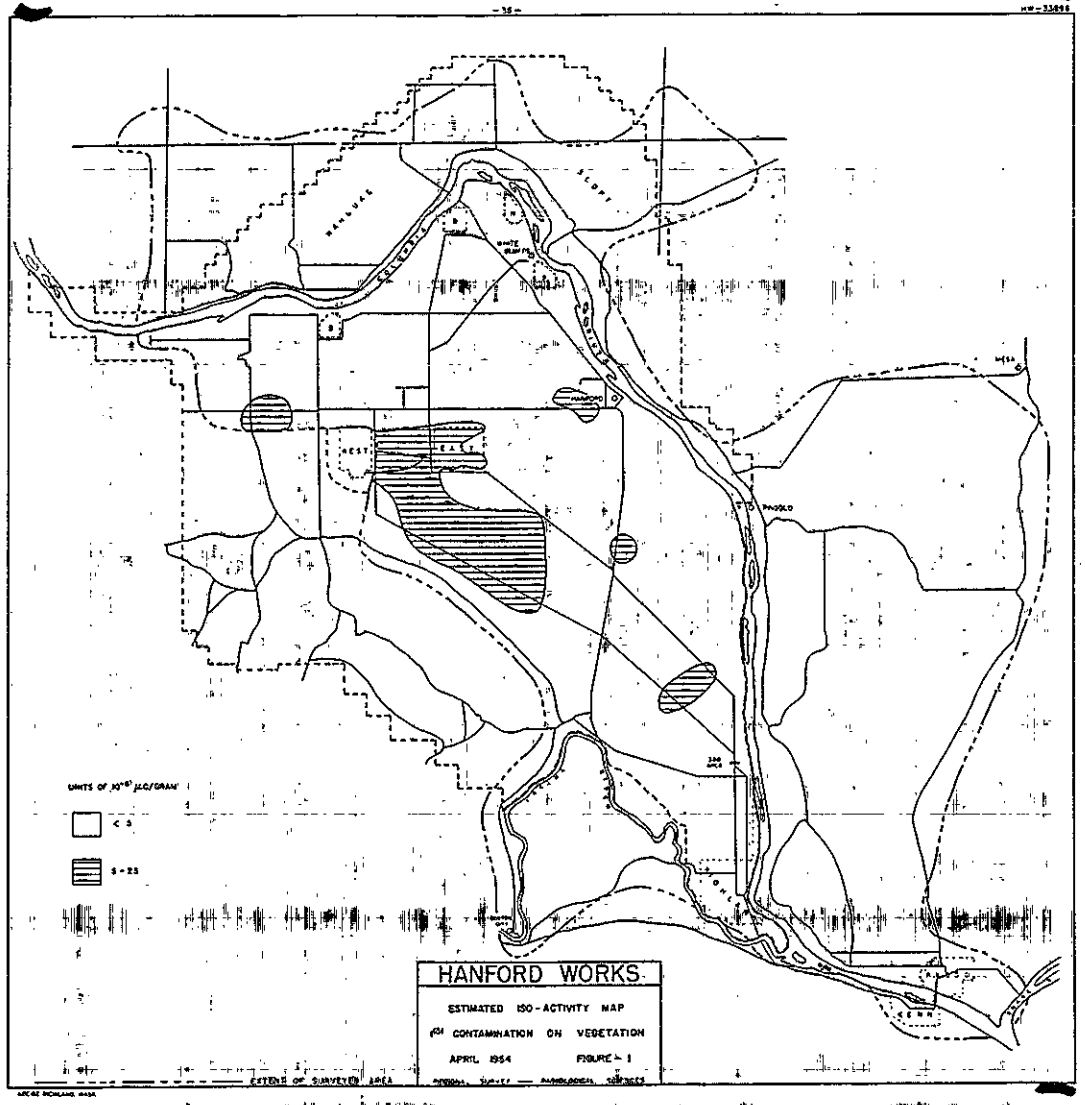
1954

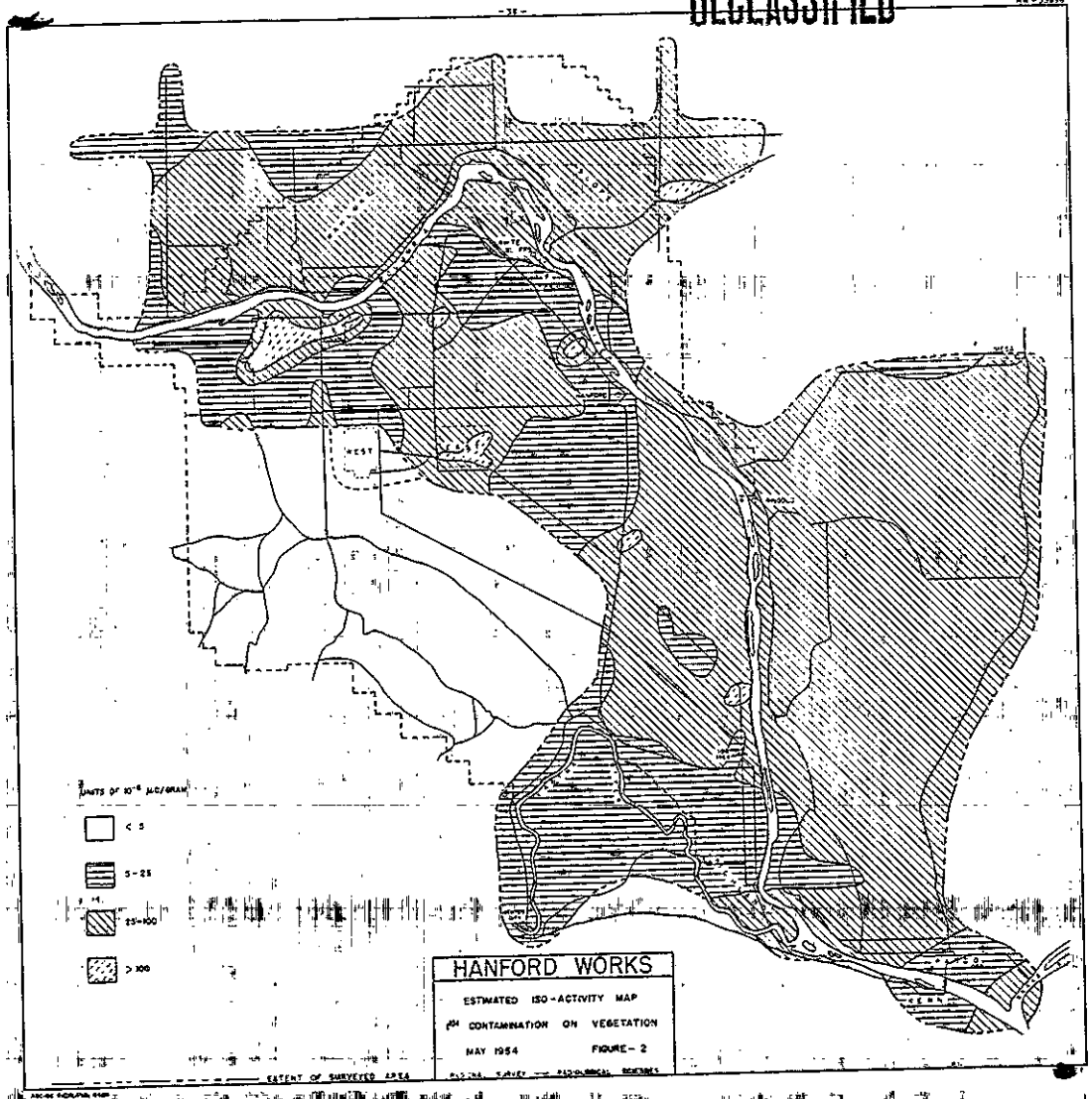
Units of 10^{-8} µc/g

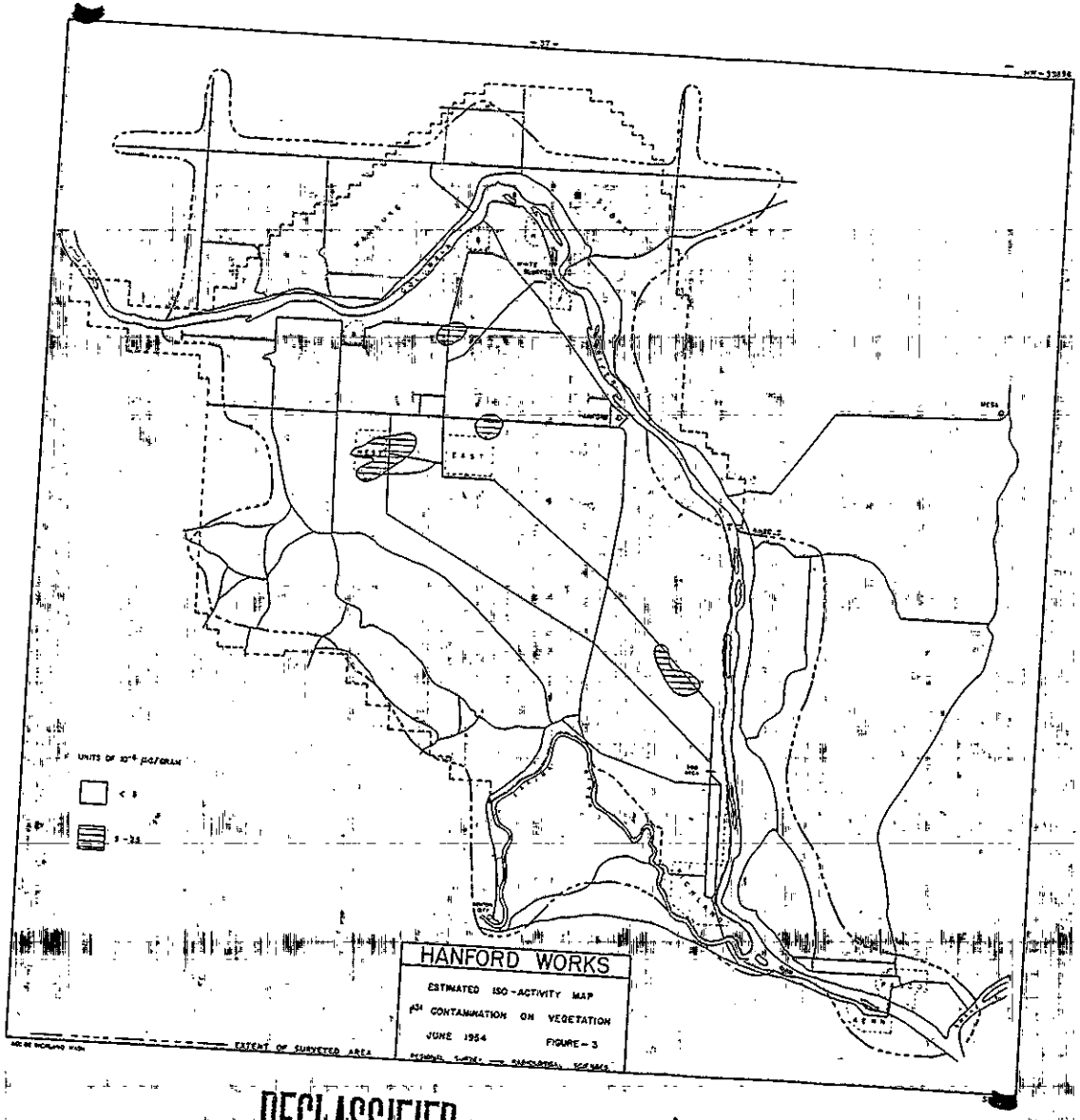
Location	April	May	June	Quarterly Avg.	Max. Result
200 West Gatehouse	240	50	40	99	370
Batch Plant	47	16	12	25	55
Rt. 4S, Mile 4	28	38	11	26	58
Meteorology Tower	130	73	<10	70	220
Rt. 4S, Mile 6	14	12	<10	<10	24
300 Area	21	19	16	18	38
Outlying					
Richland	<10	17	<10	<10	18
Pasco	35	<10	<10	16	60
Benton City	<10	<10	<10	<10	12

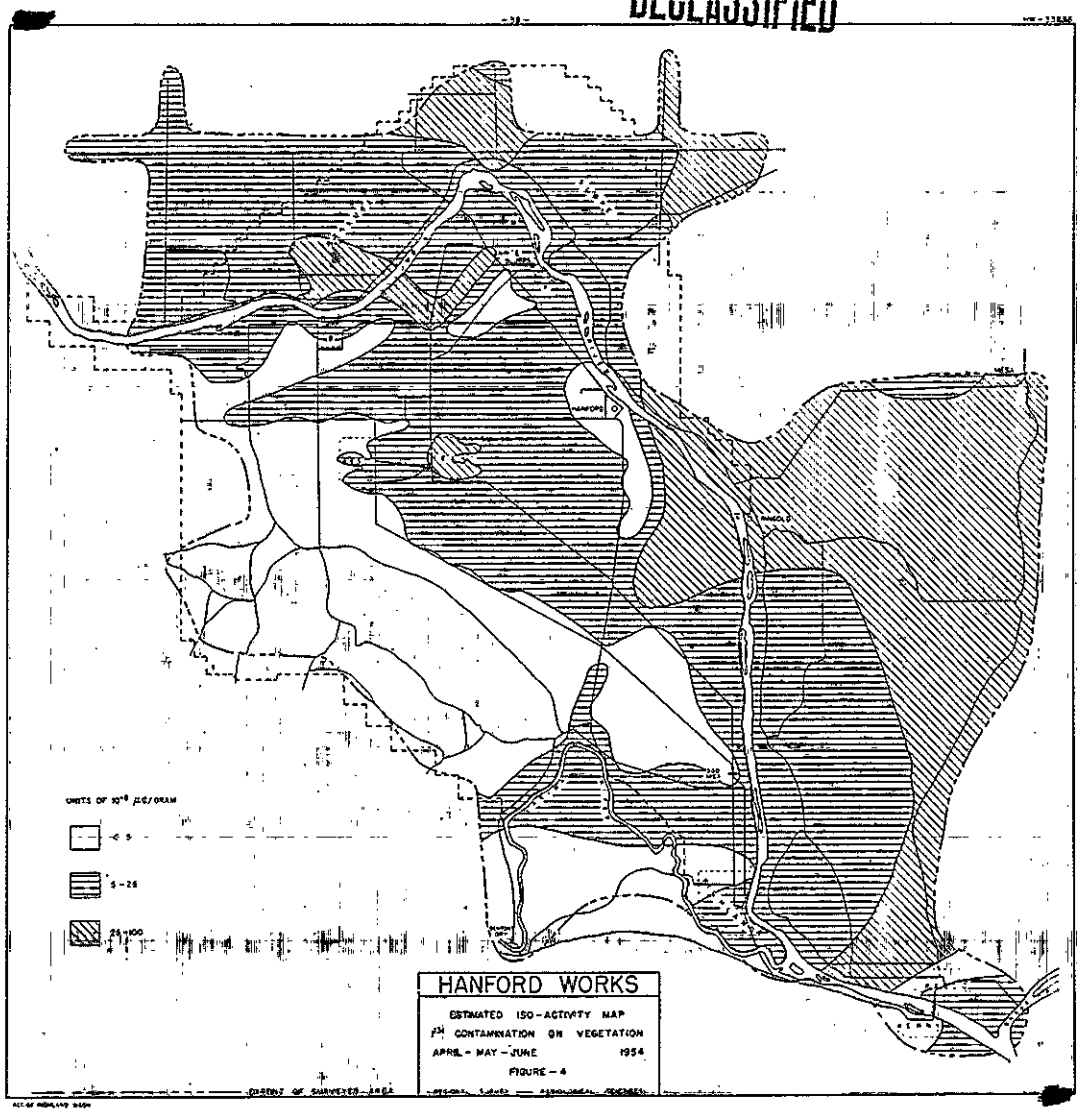
Although trace alpha particle emission was detected on samples collected near the separation areas, the orders of magnitude shown in Table V range from 1/2 to 1/10 of previous values. The values summarized in Table V were essentially on the order of magnitude expected for normal HAPO operation.

[redacted]









SECTION III

RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

The magnitude and extent of airborne contamination in the HAPO environs were determined from analysis of filter and scrubber samples and from data recorded in the operation of Victoreen Integrons and detachable ionization chambers. The following tables summarize the results obtained by measurements made by each of the monitoring methods during the quarter.

Victoreen Integrons were operated continuously at stations located at the perimeter of the manufacturing areas and in residential communities neighboring the plant. Accumulated dosage readings were tabulated by eight hour intervals and calculated in units of measured dosage per 24 hours. A summary of the average dose rates for the three month period is given in Table I.

TABLE I

AVERAGE DOSAGE RATES AS MEASURED BY VICTOREEN INTEGRONS

APRIL, MAY, JUNE

1954

Units of mrads per 24 hours

Location	No. of Units	April	May	June	Quarterly Average
100-B Area	3	0.1	0.1	0.1	0.1
100-D Area	3	0.1	<3.9	<2.9	<2.3
100-F Area	3	0.1	<0.1	0.7	<0.3
100-H Area	3	0.4	0.4	1.4	0.7
200 West Area	2	4.3	3.2	5.3	4.3
200 East Area	2	0.1	0.2	<0.1	<0.1
Riverland	1	<0.1	0.4	0.3	<0.3
300 Area	1	<0.1	0.7	<0.1	<0.3
Richland	1	<0.1	0.5	<0.1	<0.2
Pasco	1	<0.1	0.7	<0.1	<0.3
Benton City	1	<0.1	0.5	<0.1	<0.2
North Richland North	1	<0.1	0.2	<0.1	<0.1
Hanford	1	0.2	<0.1	0.1	<0.1
Kennewick	1	<0.1	0.6	<0.1	<0.3
Redox	1	2.0	4.8	1.3	2.7
200 East Semi-Works	1	<0.1	<0.7	<6.0	<2.3

[redacted]

Increases in average dose rates over those reported during the previous quarter were measured at 200 West Area and Redox. These were the only stations exhibiting such change, and the values were expected based upon the continued high ruthenium ground contamination existing in this vicinity. Higher than normal measurements recorded at 100-D Area and 200 East Semiworks resulted from erratic instrument operation during this period. If the questionable measurements are omitted, the quarterly average dosage rates found are 0.1 and <0.1 mrads per 24 hours at these two locations, respectively.

Detachable C-type ionization chambers were used for measuring the dosage rates present at stations located around the perimeter of the plant manufacturing areas. Duplicate instruments were used at each location with the minimum value of discharge included as the reported value. A summary of these dosage rate measurements is given in Table II.

TABLE II

DOSAGE RATES MEASURED WITH
"C" TYPE DETACHABLE IONIZATION CHAMBERS
APRIL, MAY, JUNE
1954

Units of mrads per 24 hours

Location	April	May	June	Quarterly Average
100-B Area	0.7	1.1	0.7	0.8
100-D Area	0.6	0.7	0.5	0.6
100-F Area	0.4	0.4	0.3	0.4
100-H Area	0.6	0.8	0.6	0.7
200 West Area	0.4	0.7	0.5	0.5
200 East Area	0.5	0.5	0.6	0.5
200 East Semi-Works	0.6	0.7	0.7	0.7

[redacted]

Examination of the above data revealed that there were no significant changes in the values for the current quarter from the similar measurements made during the past year.

Detachable M and S type ionization chambers were used to measure the dosage rates at intermediate locations on the project and in residential areas around the plant perimeter. Readings were obtained from these instruments at frequencies varying from daily to weekly and dosage rates were again tabulated from the chamber which showed the minimum discharge at each location. A summary of these measurements is given in Table III.

TABLE III

RADIATION LEVELS OBSERVED WITH
"M" AND "S" TYPE DETACHABLE IONIZATION CHAMBERS
APRIL, MAY, JUNE
1954

Units of mrads per 24 hours

Location	April	May	June	Quarterly Average	Group Average
100 Areas and Environs					
Rt. 1, Mile 8	0.74	0.50	0.67	0.64	
Rt. 2N, Mile 10	0.50	0.62	0.61	0.58	
Rt. 2N, Mile 5	0.83	0.97	0.80	0.87	
At White Bluffs	0.45	0.63	0.59	0.56	
Rt. 11A, Mile 1	0.97	1.66	0.95	1.19	
Hanford 614 Bldg.	1.21	0.77	0.44	0.81	
Intersection Rt. 1 and Rt. 4N	0.45	0.44	0.54	0.48	
At Hanford 101 Bldg.	0.39	----	----	0.39	
P-11 Area	0.47	0.74	0.59	0.60	0.68

[redacted]

TABLE III (contd.)

Units of mrads per 24 hours

Location	April	May	June	Quarterly Average	Group Average
Within 5 Miles of 200 East Area					
Rt. 4S, Mile 6	1.12	2.04	1.37	1.51	
Batch Plant	6.88	6.12	3.07	5.36	
Rt. 11A, Mile 6	1.78	>5.80	2.14	>3.24	
Rt. 3, Mile 1	2.24	1.89	1.40	1.84	
Rt. 4S, Mile 2.5	1.45	1.96	2.96	2.12	
Redox Area	1.70	2.15	2.71	2.19	
Rt. 4S, Mile 4.5	0.80	1.69	1.66	1.38	
Military Camp PSN 300	4.14	3.02	2.18	3.11	
PSN 310	1.27	1.78	2.53	1.86	
PSN 320	1.26	2.91	1.81	1.99	
PSN 330	0.88	1.94	1.51	1.44	
Redox Perimeter	32.96	37.45	33.62	34.68	>5.06
Within 10 Miles of 200 East					
Rt. 4S, Mile 10	0.59	1.20	0.85	0.88	
Rt. 10, Mile 1	1.09	1.53	1.12	1.25	
Rt. 10, Mile 3	0.92	1.68	1.02	1.21	
Rt. 2S, Mile 4	1.21	1.81	1.86	1.63	1.24
Near 300 Areas					
Rt. 4S, Mile 16	1.00	2.11	1.37	1.49	
Rt. 4S, Mile 22	1.76	>5.75	2.44	>3.32	
North Richland North	1.11	1.52	0.65	1.09	
300 Area	0.93	1.05	0.76	0.91	>1.70
Outlying					
Richland	1.21	1.04	0.80	1.02	
Benton City	0.54	0.27	0.57	0.46	
Pasco	0.30	0.34	0.34	0.33	
Kennewick	0.46	0.37	0.64	0.49	0.58

General increases over the values of the previous quarter were observed in the average dosage rates at grouped locations within a radius of 5 and 10 miles from the separation areas and near the 300 Area. The largest increase was noted at the Redox perimeter location, with a quarterly average of 35 mrads/day measured during this period. No significant differences in average dosage rates at grouped locations were observed in the environs of the reactor areas and in the outlying residential areas.

Concentrations of airborne beta particle emitters were measured using filters through which flow rates of 2 to 2.5 cfm of air were passed for daily or weekly periods. The filter samples were analyzed several days after their removal from the sampling location to allow for the decay of the daughter products of the natural airborne particle emitters. A summary of the results obtained from these measurements during this period is given in Table IV.

TABLE IV

AIRBORNE BETA PARTICLE EMITTERS MEASURED ON AIR FILTERS

APRIL, MAY, JUNE

1954

Activity Density - Units of 10^{-14} µc/cc

Location	April	May	June	Quarterly Average	Weekly Maximum
100 Areas and Vicinity					
100-D Area	29	750	31	230	2100
100-H Area	14	160	26	54	390
Hanford 614 Bldg.	16	44	9	24	100
White Bluffs	25	270	30	130	660
200 Areas and Vicinity					
200 West Tower #4	46	480	30	180	1600
200 West, Redox Area	1100	1700	140	900	3600
Gable Mountain	63	220	36	100	700
200 East Semi-Works	73	74	35	62	200
PSN 329	40	220	66	99	370
300 Area 614 Bldg.	28	45	13	28	110
Outlying					
North Richland	17	15	32	22	66
Pasco	15	67	21	34	150
Benton City	9	49	14	26	110
Riverland	28	180	19	81	530

[redacted]

The quarterly average of activity densities of beta particle emitters collected on air filter samples increased generally at nearly all stations in the vicinity of the 100 and 200 operating areas and also at Riverland. Examination of the data, however, revealed that these increases were due almost entirely to high concentrations measured during the month of May. The maximum weekly concentrations were found during the week of May 10 - 17, 1954, indicating a possible relationship to the series of nuclear and thermonuclear test explosions held by the Atomic Energy Commission in the Pacific Islands. Further radiochemical analysis of air filters as well as decay curve studies made of air and rain water samples collected during this period also revealed the presence of material typical of fall out debris. Values measured during the remaining two months of the quarter were essentially normal.

Additional evaluations of the activity density of beta particle emitters in the atmosphere were made by analyzing the small air filters removed from dual unit monitors operated at three locations. The results of these measurements are given in Table V.

TABLE V

AVERAGE BETA PARTICLE EMITTERS COLLECTED ON AIR FILTERS

DUAL UNIT AIR MONITOR

APRIL, MAY, JUNE

1954

Activity Density - Units of 10^{-14} µc/cc

Location	April	May	June	Quarterly Average	Weekly Maximum
200 West Area #1	46	310	36	120	1000
200 West Area #2	89	260	39	120	700
200 East Area #1	40	130	54	78	360
200 East Area #2	57	72	36	62	200
Richland #1	16	450	12	150	1600
Richland #2	<4	750	110	300	2200

[redacted]

The quarterly averages shown in Table V reflect the same increase noted in the results shown in Table IV. In this latter case also, the maximum weekly concentrations were measured during the week of May 10 - 17, 1954.

The number of radioactive particles in the atmosphere was determined by autoradiographing air filters through which sample air flow rates of from 2.5 to 10 cfm were passed for periods ranging from daily to weekly. Monitoring stations were maintained throughout the immediate plant environs and at several remote locations in Washington, Oregon, Idaho, and Montana in order to evaluate particles originating both from HAPO and from outside sources. All filters were autoradiographed for 168 hours using type K X-ray film. A summary of the results of measurements near the separation areas is given in Table VI.

TABLE VI

SUMMARY OF PARTICLE CONCENTRATIONS NEAR THE SEPARATION AREAS

APRIL, MAY, JUNE

1954

Units of 10^{-3} particles/meter^3

Location	Total Volume of Air Sampled Cubic Meters	April	May	June	Present Quarter Averages	Previous Quarter Averages
200-E and Vicinity						
2704 Outside	9316	36	230	130	140	63
BY - SE	9312	89	140	280	170	61
BY - NE	9027	81	120	85	99	82
"B" Gate	8823	74	300	100	170	60
2704 Inside	9304	38	160	110	110	63
200-W and Vicinity						
2701 Outside	8743	48	250	120	150	97
2722	9073	66	250	100	150	120
"T" Gate	9308	91	190	83	130	110
222-T Outside	9312	160	240	160	190	140
231	9312	54	220	180	160	110
Redox	8943	230	1700	860	960	280
"W" Guard Tower	9308	180	210	260	210	78
2701 Inside	9312	55	290	110	160	73
272	9355	45	120	81	83	89
SX Tank Farm	5763	240	630	690	480	---
222-U Lab.	7744	99	410	33	230	110
222-T Lab.	4280	50	180	*	92	72
222-T Hallway	4280	140	360	*	180	100
"U" Plant Gate	9391	160	260	120	190	150
Meteorology Tower						
3'	37247	14	67	25	38	19
50'	37604	11	32	22	22	18
100'	29863	8.7	50	37	33	23
150'	26102	11	68	30	39	23
200'	24111	19	58	44	42	31
250'	24111	18	43	41	35	44
300'	22341	27	61	52	48	48
350'	22341	17	63	80	54	35
400'	15042	44	69	94	69	51

* Discontinued

---New Monitoring Station

[redacted]

General increases in particle concentrations during the current period were noted for nearly every sampling location. Examination of the data by months shows that these increases occurred almost entirely in the months of May and June, a fact which indicates that the measurements were weighted by probable particulate contamination from sources other than Hanford.

Similar results of particle measurements made outside the separation areas and at remote locations are given in Table VII.

TABLE VII

SUMMARY OF PARTICLE CONCENTRATIONS OUTSIDE THE SEPARATION AREAS

APRIL, MAY, JUNE

1954

Units of 10^{-3} particles/meter^3

Location	Total Volume of Air Sampled Cubic Meter	April	May	June	Present Quarter Averages	Previous Quarter Averages
Area Locations						
100-B Area	9274	15	220	89	120	140
100-D Area	35377	5.4	41	16	23	17
White Bluffs	37145	17	73	49	38	19
100-F Area	29869	34	59	19	36	20
300 Area	37230	20	110	43	60	16
Off Area Locations						
Benton City, Wn.	37128	34	51	70	52	24
Pasco, Wn.	37077	10	68	46	43	6.6
Richland, Wn.	38080	34	160	38	83	21
Boise, Idaho	8989	23	120	260	130	1.6
Klamath Falls, Ore.	9180	27	130	250	130	3.2
Great Falls, Mont.	9388	5.7	30	170	62	0.5
Walla Walla, Wn.	9623	32	180	90	110	6.1
Meacham, Ore.	9275	9.3	18	140	66	0.4
Lewiston, Idaho	9394	34	380	110	190	1.6
Spokane, Wn.	37825	7.6	130	42	63	5
Kennewick, Wn.	9307	49	220	60	130	19
Yakima, Wn.	37536	8.1	150	43	65	1.2
Seattle, Wn.	9524	5.6	130	32	59	---

---New Monitoring Station

[redacted]

Particle concentrations at remote locations throughout the Pacific Northwest also evidenced significant increases during the current quarter, primarily occurring during the months of May and June. Peak concentrations were noted at each location during the period of May 9 - 18, 1954, again indicating the effect of probable contamination occurring from off-site.

The activity density of I^{131} in the atmosphere was determined from the radiochemical analysis of caustic scrubber solutions through which air flow rates of 2 to 2.5 cfm were passed for periods ranging from one to seven days. The results obtained from these measurements are summarized in Table VIII.

TABLE VIII

AVERAGE ACTIVITY DENSITY OF I^{131} DETECTED IN AIR SCRUBBERS

APRIL, MAY, JUNE

1954

Units of 10^{-12} µc/cc

Location	April	May	June	Quarterly Average	Weekly Maximum
200 Area and Vicinity					
200 East - Southeast	<0.1	0.1	<0.1	<0.1	0.4
200 East Tower #16	0.3	0.8	0.3	0.5	5.8
Gable Mountain	0.2	<0.1	0.1	<0.1	0.4
200 West Area Gate	<0.1	0.8	0.8	0.5	2.0
200 West Tower #4	<0.1	0.3	0.2	0.2	0.7
200 East Semi-Works	0.2	0.1	0.3	0.2	0.5
Redox Area	0.2	0.6	0.2	0.3	0.7
Outlying Areas					
100-H Area	<0.1	<0.1	0.1	<0.1	0.5
300 Area	<0.1	<0.1	0.2	0.1	0.8
North Richland	0.4	0.1	<0.1	0.2	1.4
Richland	<0.1	0.1	<0.1	<0.1	0.2
Pasco	0.3	0.1	<0.1	0.1	0.6
Benton City	<0.1	<0.1	0.2	<0.1	0.4

There were no significant changes from the previous quarter in the measured I^{131} activity densities either in the vicinity of the separation areas or in the outlying areas.

The activity density of alpha particle emitters in the atmosphere was determined by counting the same filters used for the beta particle emitter measurements which were summarized in Tables IV and V above. A summary of the alpha measurements is given in Table IX.

TABLE XI

CONCENTRATION OF AIRBORNE ALPHA PARTICLE EMITTERS

APRIL, MAY, JUNE

1954

Activity Density - Units of 10^{-15} μc/cc

Location	Samples	Weekly Maximum	Quarterly Average
200 West Tower #4	13	19	10
200 East, Semi-Works	13	4	<4
Gable Mountain	13	23	6
Pasco	12	13	6
300 Area	14	22	7
100-D Area	11	15	7
Benton City	12	<4	<4
Hanford 614 Bldg.	13	<4	<4
White Bluffs	13	16	<4
North Richland North	13	5	<4
200 West Redox Area	13	20	5
100-H Area	12	5	<4
Riverland	14	11	<4
PSN 320	4	15	7
Redox Experimental Unit	12	9	5
Dual Unit Monitors			
200 WEC #1	12	24	6
200 WEC #2	12	14	6
200 ESE #1	12	9	<4
200 ESE #2	10	7	<4
Richland #1	13	58	8
Richland #2	8	13	4

The concentrations of alpha particle emitters compared favorably with those previously reported at all locations, and indicate normal operations at HAPO.

SECTION IV

RADIOACTIVE CONTAMINATION IN HANFORD WASTES

The amount of radioactive contamination discharged in waste material from the manufacturing areas was determined by analyzing over 1000 liquid and solid samples for the activity density of gross beta and alpha particle emitters. The samples were collected from the various waste sources at frequencies ranging from daily to weekly, and the measurements were supplemented with the results of portable instrument surveys performed at the perimeter of the open waste areas. Special ground contamination surveys were performed after all incidents of known contamination deposition. The results of these measurements are summarized for each of the manufacturing areas.

100 AREA WASTES

Radioactive contamination discharged to the Columbia River from the reactor areas was determined by analyzing samples collected daily from the outlets of the coolant water retention basins. The samples were analyzed within twelve hours after collection and the measured counting rates of beta particle emitters were corrected for decay. A summary of the activity density of beta particle emitters in the reactor effluent water is given in Table I. A summary of the activity of materials discharged to the Columbia River per unit of time is given in Table IA.

TABLE I

RADIOACTIVE CONTAMINATION IN REACTOR EFFLUENT WATER DURING PERIODS OF NORMAL OPERATION

APRIL, MAY, JUNE

1954

Activity Density from Gross Beta Particle Emitters

Units of 10^{-3} µc/cc

Location	No. Samples	April Max.	April Avg.	May Max.	May Avg.	June Max.	June Avg.	Quarterly Max.	Quarterly Avg.
100-B Area	68	7.1	6.0	7.0	5.5	5.2	4.2	7.1	5.3
100-C Area	71	6.6	5.3	9.2	5.7	5.2	3.6	9.2	5.0
100-D Area	94	11	7.5	6.8	5.1	10	6.3	11	6.0
100-DR Area	100	10	6.5	8.7	6.3	7.0	5.9	10	6.3
100-F Area	88	10	6.6	7.9	5.8	6.7	5.6	10	6.0
100-H Area	97	12	8.3	8.2	6.0	5.7	5.1	12	6.3

TABLE IA

BETA PARTICLE EMITTERS DISCHARGED TO RIVER IN REACTOR EFFLUENT

APRIL, MAY, JUNE

1954

Units of µc/sec

Location	No. Samples	April Max.	April Avg.	May Max.	May Avg.	June Max.	June Avg.	Quarterly Max.	Quarterly Avg.
100-B Area	68	21000	17000	21000	17000	16000	13000	21000	16000
100-C Area	71	34000	27000	49000	30000	29000	20000	49000	27000
100-D Area	94	33000	22000	20000	15000	30000	19000	33000	18000
100-DR Area	100	27000	17000	24000	17000	19000	16000	27000	17000
100-F Area	88	30000	19000	22000	16000	19000	16000	30000	17000
100-H Area	97	39000	27000	27000	20000	19000	17000	39000	21000

A comparison of the total activity of beta particle emitters discharged to the river during this period with the results of similar measurements obtained during the previous quarter showed that significant increases in the activity of beta particle emitters admitted to the river occurred at the 100-C, 100-D, 100-F, and 100-H areas. Values for the 100-B and 100-DR areas showed no significant change. The general increases from the former areas can be considered to be related to expected seasonal variations in the coolant water quality, a phenomenon which has been common to the spring "run-off" season for the past several years. In the case of 100-B and 100-DR Areas, these expected increases were masked by changes in the chemical treatment of the process water, which in turn influenced the radioisotopic content of the effluent.

The activity density of alpha particle emitters in reactor effluent water averaged less than 5×10^{-9} μc/cc at all areas. Trace activity from alpha particle emitters was found in individual samples from each area with values ranging from 6×10^{-9} to 3×10^{-8} μc/cc.

Radiochemical analysis of 132 effluent water samples from all reactor areas for the activity density of uranium revealed all values to be below the detection limit of 2×10^{-9} μc/cc.

Five out of twenty samples which were analyzed for plutonium showed values above the detection limit of 3×10^{-9} μc/cc. These significant activity densities ranged from 3.2×10^{-9} to 6.3×10^{-9} μc/cc at several areas. One value of 5.6×10^{-8} μc/cc was recorded at 100-B Area on April 6.

Positive quantities of polonium were found in fourteen out of twenty samples of effluent water from each of the reactors. The activity densities varied from the detection limit of 6×10^{-10} to 2.0×10^{-9} μc/cc with one individual sample measuring 2.0×10^{-8} μc/cc at 100-B Area on April 6.

The activity density of I^{131} in waste discharged to the Columbia River from the Biology Farm at 100-F Area was measured by analyzing composite samples collected from the sump in the waste discharge line. On the average, 30 μc/day were discharged to the river during the quarter, a value comparing favorably with the discharge rate of the previous period.

200 AREA WASTES

Liquid and solid samples were collected directly from the waste sources in the separations areas and analyzed for gross alpha and beta particle emitters. A summary of the results is given in Table II.

TABLE II

RADIOACTIVE CONTAMINATION IN THE 200 AREA WASTE SYSTEMS

APRIL, MAY, JUNE

1954

Liquid Samples

Location	No. Samples	Alpha Particle Emitters, Unit of 10^{-8} µc/cc, Maximum	Alpha Particle Emitters, Unit of 10^{-8} µc/cc, Average	Beta Particle Emitters, Units of 10^{-7} µc/cc, Maximum	Beta Particle Emitters, Units of 10^{-7} µc/cc, Average
T-Ditch	9	1.0	0.5	44	13
T-Swamp	25	2.6	0.5	110	11
U-Swamp	20	130	7.3	300	45
Laundry Ditch	19	6.3	1.7	21	4.5
231 Ditch	23	43	3.9	12	3.2
200-E "B" Ditch	32	5.5	0.5	16	2.7
200-E "B" Swamp	10	4.9	1.5	19	6.7
234-35 Ditch	12	140	28	29	5.9
222-S Swamp	1	0.5	0.5	3.2	3.2
Redox Basin	1	4.0	4.0	690	690

Solid Samples

		Units of 10^{-6} µc/g		Units of 10^{-5} µc/g	
T-Ditch	8	2.5	1.3	580	220
T-Swamp	17	61	16	650	260
Laundry Ditch	11	23	12	140	36
200-E "B" Ditch	30	6.4	1.4	93	23
200-E "B" Swamp	11	89	12	47	17
234-35 Ditch	12	14000	3600	460	46
222-S Swamp	1	---	---	1200	1200

The various increases and decreases noted when comparing the measurements summarized in Table II with the data collected during the previous period were not significant because of the large fluctuations normally found between individual measurements at the 200 Area waste sources.

Samples from all waste sources indicated in Table II were analyzed specifically for the activity density of uranium. A summary of activity densities above the detection limits of 2×10^{-9} μc/cc for liquids and 1×10^{-6} μc/g for solids is given in Table III.

TABLE III

URANIUM ACTIVITY DENSITY IN 200 AREA WASTE SYSTEMS

APRIL, MAY, JUNE

1954

Liquid Samples

Location	No. Samples	Activity Density Units of 10^{-9} µc/cc Maximum	Average
231 Ditch Pipe Outlet	12	10	2.1
234-35 Pipe Outlet	12	43	5.9
Laundry Ditch	11	120	17
Laundry Ditch 600' from Inlet	10	97	17
200-E "B" Swamp Inlet	7	21	3.7
200-W "U" Swamp Inlet	10	8.8	2.7
200-W "U" Swamp W. Side	9	100	16
200-E "B" Swamp N. Side	2	1.8	1.4

Solid Samples

Location	No. Samples	Activity Density Units of 10^{-6} µc/g Maximum	Average
200-E "B" Ditch Inlet	6	24	4.3
234-35 Pipe Outlet	12	8.0	1.9
Laundry Ditch Inlet	11	120	21
200-E "B" Swamp N. Side	2	29	15
200-W "T" Swamp S. Side	6	4.2	1.8
200-W "T" Swamp W. Side	9	6.6	2.3

The order of magnitude of the activity density of uranium at these locations is similar to that reported in previous periods.

Portable instrument surveys were maintained on a weekly basis at the one hundred control plots in and adjacent to the 200-W Area. General ground contamination ranging from several thousand counts/minute/particle (GM type meter) up to 50 mrads/hr/particle was measured throughout the previously defined contaminated area (HW-31818, Figure 8) during the first two months of the quarter. Increases in dosage rates were noted during the month of June; readings obtained during the latter part of the month showed many particles with dose rates above 500 mrads/hr inside the 200-W Area. Locations a mile from the stack showed values up to 50 mrads/hr. Figure 5 shows the maximum dosage rates measured at control plots during the last week of the quarter. Surveys at perimeter locations showed negligible ground contamination at that time. The contaminating material was found to consist of ruthenium and rhodium.

Radioactive contamination measured around the perimeter of the open waste areas and waste ditches inside the separation areas remained at the low levels previously noted. Readings of several thousand counts per minute on a GM instrument were noted in several instances but dose rates measured with a CP meter were all less than 6 mrads/hr.

300 AREA WASTES

A summary of the results obtained by analyzing liquid and solid samples from 300 Area waste sources is given in Table IV.

TABLE IV

RADIOACTIVE CONTAMINATION IN 300 AREA WASTES

APRIL, MAY, JUNE

1954

Liquid Samples

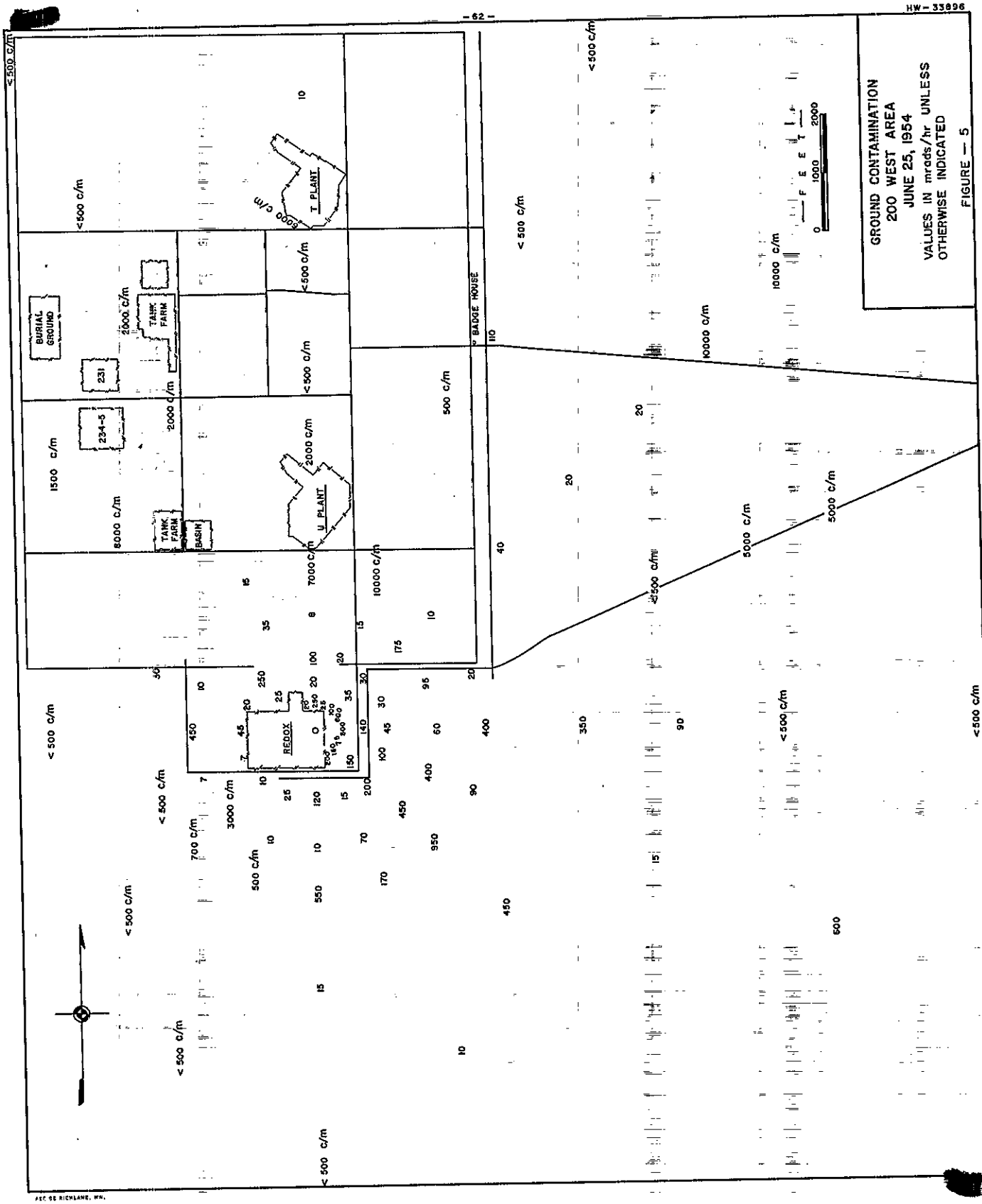
Location	No. Samples	Beta Particle Emitters Units of 10^{-7} µc/cc Max.	Beta Particle Emitters Units of 10^{-7} µc/cc Avg.	Alpha Particle Emitters Units of 10^{-8} µc/cc Max.	Alpha Particle Emitters Units of 10^{-8} µc/cc Avg.	Uranium Units of 10^{-6} µc/cc Max.	Uranium Units of 10^{-6} µc/cc Avg.
Old Pond Inlet	56	760	17	2300	88	22	0.66
New Pond Inlet	55	510	18	3200	260	30	2.1

Solid Samples

		Units of 10^{-3} µc/g		Units of 10^{-3} µc/g		Units of 10^{-3} µc/g	
Old Pond Inlet	12	17	3.9	22	2.7	11	4.1
New Pond Inlet	11	4.8	2.7	14	2.4	20	7.2

The amounts of contamination measured in samples collected from 300 Area wastes were within the order of magnitude expected when comparing the present values with similar measurements obtained during previous periods. The considerable variation in activity density found at these sources is associated with the varying amounts of material entering the waste ponds at the time the samples were collected.

Radiochemical analyses of fifty samples obtained from both the 300 Area ponds showed the average activity density of plutonium to be 1.0×10^{-8} µc/cc. Maximum concentrations measured were 2.8×10^{-8} and 8.2×10^{-8} µc/cc at the old and new ponds, respectively.



SECTION V

RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER AND RELATED WATERS

Over 1,000 water samples were collected from the Columbia River and related waters for purposes of determining the radioactive contamination resulting from the addition of reactor cooling water at the six HAPO reactor areas. These samples were analyzed for the activity density of gross alpha and gross beta particle emitters and, in isolated cases, specific analyses for uranium and/or plutonium were performed. The sampling frequency at selected locations varied from daily to weekly in the immediate environs and was maintained on a monthly basis at remote downstream locations. The volume of sample analyzed was 500 ml in all cases except those which represented sampling locations below McNary Dam where the volume analyzed was 1 gallon. Table I summarizes the results obtained from analyzing samples collected at locations in the immediate environs for the activity density of gross beta particle emitters.

TABLE I

AVERAGE CONTAMINATION FROM GROSS BETA PARTICLE EMITTERS IN RIVER WATER

APRIL, MAY, JUNE

1954

Units of 10^{-8} µc/cc

Location	April Avg.	May Avg.	June Avg.	Qtr. Avg.	Last Qtr. Avg.	Max. This Qtr.
Wills Ranch	<5	14	<5	8	<5	48
181-B Area	<5	13	<5	7	7	40
181-C Area	6	14	<5	7	7	41
Allard Station	100	47	110	80	500	480
181-D Area	180	240	52	160	730	450
181-H Area	500	450	100	320	1000	860
Below 100-H Area	1100	350	1100	850	800	1600
181-F Area	980	870	260	650	1200	1500
Below 100-F Area	1700	670	580	1200	1400	2400
Hanford South Bank	1700	1100	280	1000	1400	3400
Hanford Middle	1700	900	290	1000	1100	3600
Hanford North Bank	770	550	90	500	440	2500
300 Area	590	390	160	470	470	690
Byers Landing	660	82	--	370	90	660
Richland	280	270	120	210	370	470
Kennewick Highlands Pumping Station	240	260	90	200	270	420
Pasco Bridge (Kenn. Side)	150	150	57	120	140	320
Pasco Pridge (Pasco Side)	200	170	58	150	210	410
Pasco Pumping Plant	280	240	70	210	230	500
Sacajawea Park	120	150	63	110	94	240
McNary Dam	21	10	31	27	22	45
McNary Pool	36	31	15	24	25	43
Paterson	18	26	21	20	18	30
Snake River at Mouth	21	51	21	29	14	100
Yakima River at Mouth	<5	5	<5	<5	<5	13
Yakima River - Horn	<5	<5	<5	<5	<5	<5
Yakima River at Prosser	<5	<5	<5	<5	<5	7
300 Area Pond Inlet	<5	6	<5	<5	6	10

The expected seasonal increase in the flow rate of the Columbia River resulted in an increase in the ratio of river water to reactor effluent and caused a decrease in the activity density of beta particle emitters in river samples at nearly all locations during this period. The measured flow rate of 474,000 gallons/second on April 24 increased progressively during the quarter to a flow of 3,075,000 gallons/second on May 29 and remained at a flow comparable to this maximum measurement during the remainder of the period. The average flow rate over the three month period was 1,590,000 gallons/second as compared with an average of 583,000 gallons/second during the previous three month period. Average flow rates during the months of April, May, and June were 278,000, 1,230,000, and 2,950,000 gallons/second, respectively.

Samples collected directly below the 100-H area during the latter part of the quarter did not follow the trend observed from the results obtained at other locations because the increased elevation of the Columbia River caused a significant volume of reactor cooling water to be discharged to the river via the emergency spillway instead of through the effluent discharge pipe. The spillway discharges the active water near the shoreline and does not allow the rapid dispersion that is found at the end of the effluent discharge pipe.

Monthly samples were collected from ten locations between McNary Dam and Portland, Oregon. Trace beta particle emission was detected in all samples with values ranging from 2.7×10^{-8} to 9.7×10^{-8} $\mu c/cc$ during April, 2.9×10^{-8} to 1.2×10^{-7} $\mu c/cc$ during May, and 2.0×10^{-8} to 6.9×10^{-8} $\mu c/cc$ during June. The maximum measurements were obtained at The Dalles during April and at Arlington during May and June. One sample was collected from the mouth of the Columbia River at Astoria, Oregon, during low tide on June 22; the activity density from beta particle emitters in this sample was 1.2×10^{-8} $\mu c/cc$ and from alpha particle emitters was less than 5×10^{-9} $\mu c/cc$.

The activity density of alpha particle emitters in the river samples collected from the Columbia River at locations between the reactor areas and McNary Dam averaged less than 5×10^{-9} μc/cc at all the locations shown in Table I.

Twenty-six samples collected from the south shore of the Columbia River at the Hanford Ferry were analyzed specifically for the activity density of I^{131} which is admitted to the river in trace quantities at the Biology Farm in the 100-F area. The average activity density in these samples was 1.4×10^{-7} μc/cc including a maximum measurement of 3.5×10^{-7} μc/cc.

Velocity studies, directed toward determining the flow time required for material admitted at the most upstream reactor (100-B) to reach the Pasco Filter Plant, were made using sub-surface floats on May 4. Results showed that the average time required for floats to travel this distance was 22.2 hours. Minimum elapsed time was 18.9 hours. The average velocity over the 54 miles of river was 2.4 mph. Maximum velocity was 2.86 mph. River flow was on the order of 800,000 gal/sec.

Radioactive contamination deposited by the waters of the Columbia River was measured by analyzing mud samples for the activity density of alpha and beta particle emitters. Samples were collected from shore and off-shore locations at weekly frequencies. Table II summarizes the results obtained from the beta particle measurements.

[redacted]

TABLE II

RADIOACTIVE CONTAMINATION IN COLUMBIA RIVER MUD SAMPLES

APRIL, MAY, JUNE

1954

Beta Particle Emitters - Units of 10^{-5} μc/g

Location	April Avg.	May Avg.	June Avg.	Qtr. Avg.	Last Qtr. Avg.	Max. This Qtr.
Wills Ranch						
Shore	2.8	4.7	3.9	3.8	3.5	8.1
5' Out	2.6	3.8	3.0	3.1	3.1	5.9
Allard Station						
Shore	3.3	3.1	3.6	3.3	3.9	4.6
5' Out	4.3	3.5	2.8	3.7	4.6	5.6
100-H Area						
Shore	7.7	4.6	4.5	5.7	5.9	16
5' Out	5.5	5.1	5.4	5.3	4.9	11
Below 100-F						
Shore	19	4.0	4.2	12	8.0	73
5' Out	17	32	4.2	20	7.8	78
Hanford Ferry						
Shore	28	7.8	3.2	14	11	97
5' Out	19	9.0	3.2	10	13	71
300 Area						
Shore	10	5.0	3.0	6.6	4.4	17
5' Out	7.4	5.9	3.4	6.0	12	13
Byers Landing Pumping Plant						
Shore	5.2	3.6	---	4.4	4.6	5.2
Richland Dock						
Shore	4.6	5.4	3.2	4.2	6.5	9.9
5' Out	3.7	4.0	3.5	3.7	4.6	6.2
Kennewick Highlands Pump. Station						
Shore	3.3	5.6	3.1	4.0	3.9	9.7
5' Out	4.8	4.2	2.8	4.1	3.3	11
P. K. Bridge (Kenn. Side)						
Shore	4.0	6.2	4.0	4.6	4.2	8.5
5' Out	4.4	12	3.7	6.2	4.3	24
Sacajawea Park						
5' Out	4.1	6.3	3.9	4.8	3.6	9.7
McNary Dam						
5' Out	4.3	4.1	4.5	4.4	2.7	7.3
Paterson						
5' Out	3.3	3.2	4.2	3.6	3.4	4.8

[redacted]

TABLE II (contd.)

Location	April Avg.	May Avg.	June Avg.	Qtr. Avg.	Last Qtr. Avg.	Max. This Qtr.
Snake River Mouth						
5' Out	2.8	2.0	3.4	2.8	2.7	5.5
Yakima River Horn						
Shore	2.7	3.8	2.5	3.0	1.7	5.3
5' Out	2.3	2.5	2.7	2.5	2.9	4.4
Yakima River - Prosser						
5' Out	1.8	2.6	1.6	2.0	2.3	3.6
McNary Cold Springs - South						
5' Out	28	6.3	5.0	11	12	28
McNary Cold Springs - Middle						
5' Out	16	15	6.2	11	16	16
McNary Cold Springs - North						
5' Out	4.5	3.6	10	6.2	13	10

The average activity density of beta particle emitters in mud samples was generally higher at near project locations than that measured in background samples. Average values 2 to 3 times above background at the 100-F area, Hanford Ferry, and at McNary Dam, represented a continuation of the higher than background values measured during the first quarter of 1954.

Radiochemical analyses of mud samples for the activity density of alpha particle emitters showed values below the detection limit of 2×10^{-6} μc/g at all locations except one directly below the 300 Area where average values ranged from 2 to 3×10^{-6} μc/g. The maximum measurement at the 300 Area location was 1.6×10^{-5} μc/g. The detection of significant alpha particle emission at this location confirmed a similar observation made during the previous quarter. Trace amounts of uranium were again found in mud samples from this location. Eleven samples showed an average of 2.4×10^{-9} μc/cc including a maximum value of 1.5×10^{-8} μc/cc.

Table III summarizes the results obtained from analyzing over 130 samples of raw water for the activity density of beta particle emitters.

TABLE III

RADIOACTIVE CONTAMINATION IN RAW WATER

RIVER EXPORT LINE

APRIL, MAY, JUNE

1954

Beta Particle Emitters - Units of 10^{-8} µc/cc

Location	April Avg.	May Avg.	June Avg.	Qtr. Avg.	Last Qtr. Avg.	Max. This Qtr.
183 Bldg., 100-B Area	<5	12	<5	5	22	33
183 Bldg., 100-C Area	<5	<5	<5	<5	<5	9
183 Bldg., 100-D Area	120	62	13	60	130	200
183 Bldg., 100-DR Area	110	62	14	63	130	270
183 Bldg., 100-F Area	160	130	27	98	190	340
183 Bldg., 100-H Area	140	64	16	72	170	220
283 Bldg., 200 East Area	86	54	<5	45	82	150
283 Bldg., 200 West Area	150	67	5	68	110	240

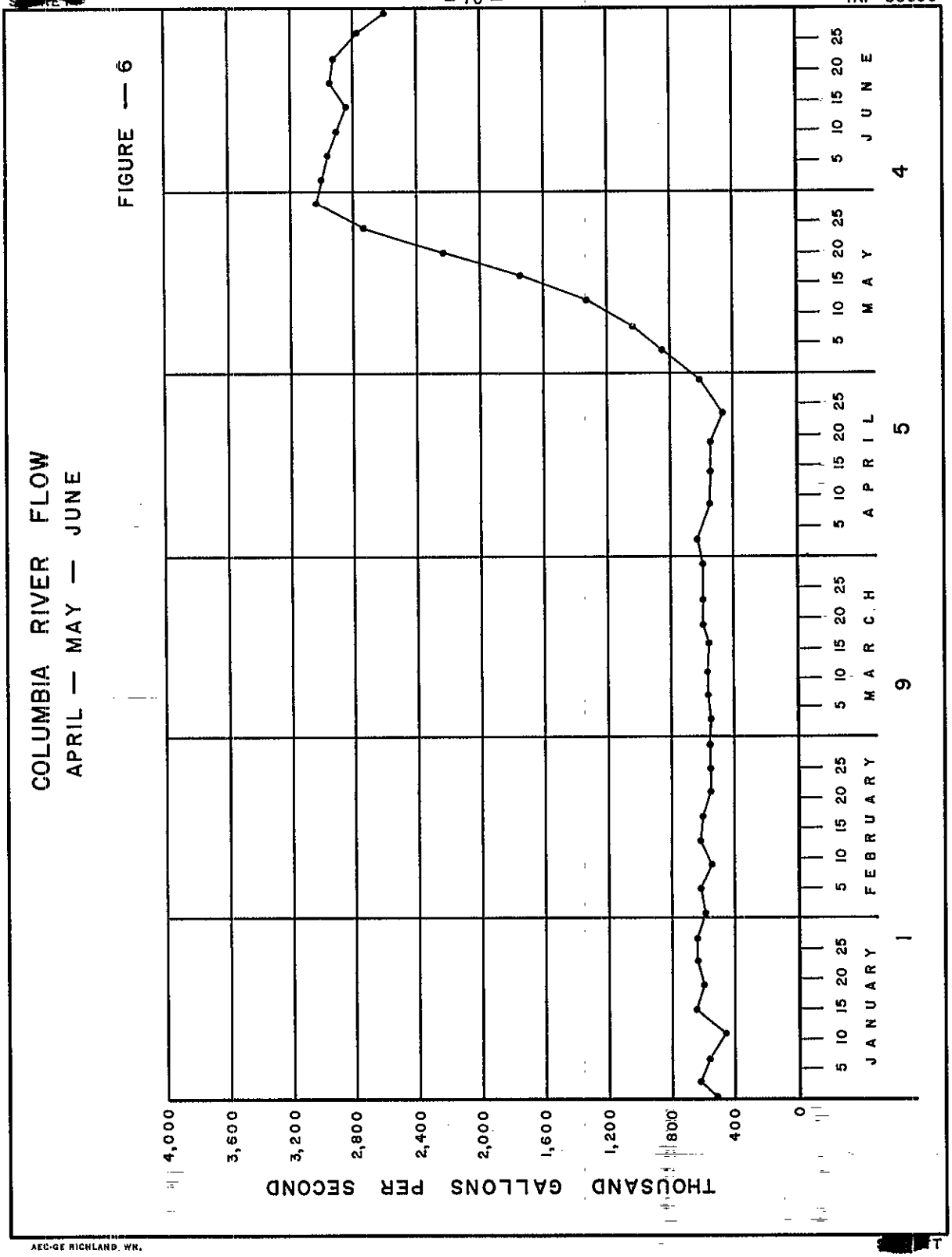
Decreases in activity density to values on the order of 1/2 of those measured during the previous quarter were caused by the decrease in activity density measured in the Columbia River from which the raw water is pumped to the various operating areas.

The results obtained from analyzing all raw water samples for the activity density of alpha particle emitters showed no indication of contamination at any time; values in all individual samples were less than 5×10^{-9} µc/cc.

[redacted]

FIGURE — 6

COLUMBIA RIVER FLOW
APRIL — MAY — JUNE



AEC-GE RICHLAND, WN.

SECTION VI

RADIOACTIVE CONTAMINATION IN RAIN

The radioactive contamination deposited in the environs by rainfall was determined from the results obtained by analyzing 100 rain samples collected from 26 scattered locations on the project. The absence of significant amounts of precipitation allowed little opportunity to evaluate this deposition during the period. Total precipitation of 0.58 inches was measured at the Meteorology Station near the 200-W Area; the 35 year average HAPO rainfall for this three month period is 1.36 inches. Table I summarizes the rainfall measurements made at the Meteorology Station in this quarter during the past several years.

TABLE I

PRECIPITATION MEASURED AT METEOROLOGY STATION

APRIL, MAY, JUNE

1954

Units - Inches

Year	April	May	June	Quarterly Total
1951	0.53	0.43	1.38	2.34
1952	0.13	0.58	1.07	1.78
1953	0.77	0.28	0.55	1.60
1954	0.07	0.41	0.10	0.58

The results obtained from analyzing rain samples for the activity density of beta particle emitters are presented in Table II.

TABLE II

ACTIVITY DENSITY OF GROSS BETA PARTICLE EMITTERS IN RAIN

APRIL, MAY, JUNE

1954

Location	Number Samples	Units of 10^{-6} µc/cc Maximum	Average
In 200 East Area	15	120	21
250' E of stack	6	120	27
2000' E of stack	5	120	20
3500' E of stack	4	17	6
In 200 West Area	16	800	110
1000' E of stack	4	200	57
7000' E of stack	3	110	38
8000' SE of stack	3	84	35
4900' SE of stack	2	130	71
Redox Area	4	800	280
100 Area Environs	17	97	23
100-B SE	1	1	1
100-D SW	3	47	22
100-F SW	5	58	18
Hanford 614	4	97	32
White Bluffs	2	85	50
100-H SE	2	5	3
Perimeter Locations	22	240	30
700A 614	6	79	17
Pasco H and R	4	130	37
Benton City	4	120	32
Riverland	4	240	66
3000 Area North	4	8	3
Intermediate Locations	30	200	34
Route 4S, Mile 6	3	80	30
300 Area 614	6	190	33
200 North 614	3	67	24
Gable Mountain	3	30	12
Batch Plant	2	160	54
622 Building	13	200	39

[redacted]

Comparison of the data summarized in Table II with results of similar measurements obtained during the previous quarter shows that the average activity density increased significantly at nearly every monitoring location. The increase in average activity density was largely caused by the results of measurements obtained during the month of May when significant quantities of radioactive debris from nuclear explosions entered the environs (Section III). Excluding the May measurements from the data, a number of the maximum measurements obtained during the period were 5 to 10 times greater than those observed during the previous quarter. This increase appeared to be related to the general contamination in and near the 200-W Area.

In contrast, the measurements obtained during this quarter were significantly lower than those measured during the same period a year ago when the activity density values were influenced by fallout from nuclear detonations at the Nevada Proving Ground (HW-28925).

Radiochemical analyses of a number of selected rain samples collected at locations shown in Table I were made for the activity density of alpha particle emitters. In all cases, the activity density was below the detection limit of 5×10^{-9} $\mu c/cc$.

[redacted]

SECTION VII

RADIOACTIVE CONTAMINATION IN DRINKING WATER SUPPLIES AND TEST WELLS

Over 2,000 samples were collected from the HAPO environs for purposes of determining the extent and magnitude of radioactive contamination in drinking water supplies and test wells. Approximately 1,700 of these samples represented water which was used for consumption purposes and the remaining 300 samples represented test wells which were used to determine the trends of the movement of the water table. Sampling frequencies based on the probability of contamination and the location of the well varied from daily to monthly. The volume of the majority of samples was 500 ml; 11.7 liter samples were analyzed when additional sensitivity appeared necessary. These measurements were supplemented with special samples obtained from the various stages of the filtration processes and retention basins in the nearby Pasco and Kennewick municipal water systems.

Table I is a summary of data from all locations at which the activity density of alpha particle emitters showed an average above the detection limit of 5×10^{-9} μc/cc during the quarter.

[redacted]

TABLE I

CONTAMINATION FROM ALPHA PARTICLE EMITTERS
IN DRINKING WATER
APRIL, MAY, JUNE
1954

500 ml samples

Location	Alpha Particle Emitters, Units of 10^{-9} µc/cc			Uranium, Units of 10^{-9} µc/cc		
	No. Samples	Max.	Avg.	No. Samples	Max.	Avg.
Richland Well #2	11	9	6	12	6	<2
Richland Well #4	57	32	6	58	14	5
Richland Well #12	12	8	6	12	10	5
Richland Well #14	12	8	6	12	6	4
Richland Well #15	7	9	6	7	7	6
Enterprise Well	13	170	15	13	11	<2
Benton City Water Co. Well	12	18	14	12	13	10
Benton City Store	13	13	12	13	13	9

The data summarized in Table I did not represent a significant change from results obtained from similar measurements during the past year. As in the past, trace quantities of uranium were found in nearly all samples which showed detectable alpha particle emission.

In addition to those locations which showed a positive average for alpha particle emission during the quarter (Table I), a number of randomly located wells and drinking water supplies showed detectable alpha particle emission at some time during the quarter. In general, the positive indications of activity in these samples barely exceeded the detection limit of the measurement, and, in the majority of cases, the values were not confirmed by resamples. Table II shows a complete tabulation of all results obtained from analyzing 500 ml samples of drinking water at locations in the immediate HAPO environs.

TABLE II

SUMMARY OF ALPHA AND BETA PARTICLE EMITTERS MEASURED IN WATER SUPPLIES

APRIL, MAY, JUNE

1954

500 ml samples

Location	No. Samples	Alpha Particle Emitters Units of 10^{-9} µc/cc Max.	Alpha Particle Emitters Units of 10^{-9} µc/cc Avg.	Beta Particle Emitters Units of 10^{-8} µc/cc Max.	Beta Particle Emitters Units of 10^{-8} µc/cc Avg.
Richland Well #2	11	9	6	6	<5
Richland Well #4	57	32	6	110	<5
Richland Well #5	12	7	<5	<5	<5
Richland Well #12	12	8	6	11	<5
Richland Well #13	13	6	<5	<5	<5
Richland Well #14	12	9	6	<5	<5
Richland Well #15	7	9	6	<5	<5
Tract House J-685	13	6	<5	41	7
3000 Area Well "A"	13	<5	<5	5	<5
3000 Area Well "B"	12	<5	<5	10	<5
3000 Area Well "C"	9	<5	<5	11	<5
3000 Area Well "D"	9	6	<5	<5	<5
3000 Area Well "E"	9	5	<5	29	<5
3000 Area Well "J"	11	9	<5	7	<5
3000 Area Well "K"	12	16	<5	8	<5
3000 Area Well "L"	8	<5	<5	7	<5
3000 Area Well "F"	10	<5	<5	<5	<5
3000 Area Well "H"	11	<5	<5	<5	<5
Durand #5	12	<5	<5	56	7
Columbia Field Well "A"	13	17	<5	<5	<5
Columbia Field Well "B"	13	<5	<5	<5	<5
Columbia Field Well "C"	13	<5	<5	15	<5
Headgate Well	13	7	<5	8	<5
1100 Area Well #8	11	9	<5	32	<5
Midway	13	11	<5	6	<5
Riverland	13	9	<5	<5	<5
Lower Knob	13	<5	<5	9	<5
Wills Ranch	12	<5	<5	<5	<5
Pistol Range	12	<5	<5	<5	<5
White Bluffs Fire Hall	13	<5	<5	79	24
White Bluffs Telephone Exchange	9	8	<5	12	5

TABLE II (contd.)

500 ml samples

Location	No. Samples	Alpha Particle Emitters Units of 10^{-9} µc/cc Max.	Alpha Particle Emitters Units of 10^{-9} µc/cc Avg.	Beta Particle Emitters Units of 10^{-8} µc/cc Max.	Beta Particle Emitters Units of 10^{-8} µc/cc Avg.
Benton City Water Co.	12	18	14	<5	<5
Benton City Store	13	13	12	8	<5
Cobb's Corner (Kiona)	13	5	<5	<5	<5
Enterprise Well	13	170	15	6	<5
Kennewick Standard Station	12	7	<5	40	18
100-B	13	<5	<5	96	14
100-C	13	<5	<5	43	5
100-D	13	<5	<5	90	26
100-DR	12	<5	<5	93	23
100-H	13	<5	<5	130	32
100-F	14	6	<5	200	50
100-K #1	11	5	<5	8	<5
200 East	13	<5	<5	64	15
200 West	12	40	<5	70	27
300 Area	13	<5	<5	9	<5
251 Building	12	<5	<5	24	8
Redox Ad. Building	13	<5	<5	21	10
Sacajawea Park	12	8	<5	<5	<5
McNary Dam	12	<5	<5	14	<5
Paterson	12	<5	<5	<5	<5
Plymouth	12	<5	<5	<5	<5
Prosser	12	<5	<5	48	5
Byers Landing Pumping Plant	2	<5	<5	90	73
Kennewick Reservoir	13	5	<5	40	16
Pasco Improvement Farm	2	<5	<5	63	32
Pasco H and R Depot	12	<5	<5	24	10
300 Area #1	8	110	16	11	<5
300 Area #3	3	94	94	16	7
300 Area North Well	2	1300	1100	8	6
B-Y Well	10	16	6	<5	<5
McGee Well	13	<5	<5	12	<5
Ford Well	13	<5	<5	5	<5
Meeker Well	12	<5	<5	<5	<5

Increased sensitivity from a detection limit of 5×10^{-9} μc/cc to 2×10^{-10} μc/cc for alpha particle emitters was made possible by analyzing 11.7 liter samples when the smaller volume samples indicated a value of questionable significance. Two hundred and thirty-four of the larger volume samples were analyzed during the period; Table III summarizes these results.

TABLE III

ACTIVITY DENSITY FROM ALPHA PARTICLE EMITTERS MEASURED IN DRINKING WATER

APRIL, MAY, JUNE

1954

11.7 liter samples

Location	No. Samples	Units of 10^{-10} μc/cc Maximum	Average
Richland Well #2	5	55	34
Richland Well #4	5	49	34
Richland Well #5	6	23	18
Richland Well #12	7	50	34
Richland Well #13	5	35	23
Richland Well #14	8	42	26
Richland Well #15	3	45	42
Tract House J-685	5	17	12
Columbia Field Well "A"	7	11	6
Columbia Field Well "B"	6	18	8
Columbia Field Well "C"	7	16	10
1100 Area Well #8	7	26	19
3000 Area Well "A"	7	9	4
3000 Area Well "B"	6	7	5
3000 Area Well "C"	3	7	5
3000 Area Well "D"	5	6	3
3000 Area Well "E"	4	6	3
3000 Area Well "J"	5	6	4
3000 Area Well "K"	6	7	6
3000 Area Well "L"	4	9	8
3000 Area Well "F"	3	15	9
3000 Area Well "H"	3	4	3
Durand #5	7	16	12
Benton City Store	7	82	53
Benton City Water Co.	5	74	61
Cobbs Corner	6	10	8
Enterprise	7	8	6

TABLE III (contd.)

11.7 liter samples

Location	No. Samples	Units of 10^{-10} µc/cc Maximum	Average
Headgate	6	11	5
Kennewick Reservoir	6	12	7
Kennewick Standard Station	6	7	6
Riverland	5	6	3
Midway	6	8	5
Lower Knob	6	2	<2
Wills Ranch	10	7	5
McGee Well	5	3	<2
Ford Well	5	<2	<2
Meeker Well	5	2	<2
White Bluffs Fire Hall	6	26	15
Pistol Range	5	10	6
B-Y Well	3	32	22
251 Bldg.	1	4	4
Clover Island Pumping Station	5	8	4
3000 Area Pond Inlet	5	39	11

[redacted]

The results summarized in Table III tend to confirm the presence of alpha particle emission on the order of 10^{-9} μc/cc in water supplies in the Richland-Benton City area. Values on the order of 10^{-10} μc/cc occurred at random locations and in many cases were not confirmed when resamples were analyzed. Uranium was usually found in samples collected from the Richland-Benton City area whereas very few of the remaining locations showed any indication of this contaminant during the period.

Periodic samples were collected from a number of miscellaneous drinking water sources on the project area. Many of these were at construction sites and military installations where water supplies are trucked from other locations and very often represent temporary or emergency drinking supplies. Radiochemical analyses of these miscellaneous samples for the activity density of gross alpha and beta particle emitters showed no values above the respective detection limits of 5×10^{-9} μc/cc and 5×10^{-8} μc/cc, respectively.

Beta particle emitters were detected in all drinking water supplies which used the Columbia River as an initial source of water and were found in all samples of material which were collected from the filtration systems of the Pasco and Kennewick water supplies. Table II includes the results obtained from the beta particle measurements in drinking water samples collected from the HAPO environs and Table IV shows a tabulation of the results obtained from samples which were collected from the Pasco Filter Plant.

TABLE IV

RADIOACTIVE CONTAMINATION MEASURED AT PASCO FILTER PLANT

APRIL, MAY, JUNE

1954

Type Sample	Samples	Activity Density Gross Beta Particle Emitters Maximum	Average
Water Entering Plant From River	11	5.0×10^{-6} µc/cc	2.1×10^{-6} µc/cc
Sand (Surface of Sand Filter)	11	2.6×10^{-4} µc/g	7.8×10^{-5} µc/g
First Backwash Material (Liquid)	11	9.6×10^{-7} µc/cc	3.9×10^{-7} µc/cc
First Backwash Material (Solid)	11	0.42 µc/g	5.9×10^{-2} µc/g
Coal (Surface of Coal Filter)	10	3.7×10^{-4} µc/g	9.2×10^{-5} µc/g
First Backwash Material (Liquid)	11	1.0×10^{-6} µc/cc	3.7×10^{-7} µc/cc
First Backwash Material (Solid)	11	8.7×10^{-2} µc/g	4.5×10^{-2} µc/g
Water Leaving Plant	12	3.7×10^{-7} µc/cc	2.0×10^{-7} µc/cc

Decreases were noted in the activity density of beta particle emitters in samples which were collected during the latter part of the quarter when the flow rate of the Columbia River increased to a value approximately 5 times greater than that noted at the beginning of the quarter. These decreases in activity density were expected as they represent a seasonal fluctuation that has been noted annually during this same period since the start-up of the Hanford operation. Considering the effect of river flow on the activity density measured in the drinking water and filtration plant samples, the beta particle measurements obtained during this period did not represent a significant departure from previous data. Some possible effect of the increased turbidity of the Columbia River during high flow was noted in samples collected from the coal filter at the Pasco Filter Plant where increases in the activity density of beta particle emitters in the solid fraction of backwash material were observed during the month of June.

Samples of foam-like material from the surface of the sand and coal filters showed an activity density of 6.6×10^{-3} and 2.7×10^{-5} $\mu c/g$, respectively.

Alpha particle emission was detected in the backwash material from both filters but was not found in the water leaving the plant. Average values for the solid fraction of the backwash material ranged from 3.7×10^{-5} to 7.3×10^{-5} $\mu c/g$. One sample of the liquid fraction from the coal filter showed a value of 5.4×10^{-9} $\mu c/cc$.

Table V summarizes the results obtained from analyzing samples collected from test wells for the activity density of alpha and beta particle emitters.

[redacted]

TABLE V

SUMMARY OF ALPHA AND BETA PARTICLE EMITTERS MEASURED IN TEST WELLS APRIL, MAY, JUNE 1954

500 ml samples

Location	Samples	Alpha Particle Emitters, Units of 10^{-9} µc/cc		Beta Particle Emitters, Units of 10^{-8} µc/cc	
		Maximum	Average	Maximum	Average
300 Area Well #1	9	110	16	11	5
300 Area Well #3	3	94	94	16	7
300 Area North Well	2	1300	1100	8	6
B-Y Well	11	16	6	<5	<5
46 - 42.5	1	<5	<5	6	6
303-1	10	990	380	22	7
303-2	9	280	58	34	6
303-3	3	1800	850	<5	<5
303-4	10	1000	530	27	7
303-5	3	98	71	<5	<5
303-6	10	1100	480	34	8
303-7	2	210	190	<5	<5
303-8	3	7	<5	<5	<5
303-9	2	130	88	<5	<5
303-10	2	350	330	<5	<5
303-11	2	10	7	<5	<5
303-12	2	160	120	<5	<5
2000-7	2	89	50	<5	<5

[redacted]

The frequency of sampling test wells was reduced during this period due to the increased work load in related portions of the environmental monitoring program. A comparison of the results summarized in Table V with smaller results obtained during the previous quarter reflected a decrease in alpha and beta particle emission for many locations. Due to the similar number of samples it was impossible to determine whether this decrease was significant; a review of related factors revealed no assignable cause for the indicated decrease.

Several samples from the 300 Area wells were analyzed specifically for uranium. Average values at wells #3 and #4 were 6.3×10^{-8} μc/cc and 2.4×10^{-8} μc/cc, respectively; a maximum measurement was obtained at well #3 in a sample with an activity density of 1.2×10^{-7} μc/cc.

[redacted]

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