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HW-27641

Health and Safety

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RADIOACTIVE CONTAMINATION IN THE ENVIRONS OF THE HANFORD WORKS FOR THE PERIOD OCTOBER, NOVEMBER, DECEMBER 1952

by

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ABSTRACT

SECTION I - RADIOACTIVE CONTAMINATION IN EFFLUENT GASES:

Total I^{131} emission from the separation facility stacks averaged 1.4 curies/day during the quarter. Maximum I^{131} emission measured at the Redox facility was 5.2 curies/day. Ruthenium emission from the Redox facility averaged less than 0.1 curie/day with a maximum emission of 0.6 curie/day during October. Weekly measurements taken ahead of the sand filter at Redox showed particle concentrations averaging on the order of 0.3 particle/ft^3 of gas; particulate contamination on samples obtained at the downstream side was negligible. Stack measurements at TBP showed average daily emission of 3.3×10^{-8} and 8.7×10^{-6} curie/day for alpha and beta particle emitters, respectively. Emission of C^{14}, S^{35}, and tritium oxide from the reactor stacks was in agreement with previous measurements. Increases in the number of particles emitted along with increases in the activity density of gross beta and alpha particle emitters at some of the reactors were associated with operating changes. Measurements to determine the activity density from argon in reactor effluent gas showed values on the order of 10^{-5} μc/cc.

SECTION II - RADIOACTIVE CONTAMINATION ON VEGETATION:

I^{131} deposition on vegetation averaged 1×10^{-5} μc/g close to the separation areas and from less than 3×10^{-6} to 5×10^{-6} μc/g in the residential area around the project perimeter. Maximum deposition was 1.3×10^{-4} μc/g near the 200 West Area. Higher values predominated during the latter part of the quarter when undesirable meteorological conditions caused low dilution of the stack effluent. In general, the deposition from I^{131} occurred at random locations during the three month period. Trace quantities of I^{131} were detected on vegetation at off-site locations during the latter part of the quarter; the activity density from I^{131} on samples collected at Touchet averaged 1.3×10^{-5} μc/g and at Lind 7×10^{-6} μc/g.

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Maximum off-site deposition was 5.4×10^{-5} μc/g at Touchet. Twofold increases in the activity density from non-volatile beta particle emitters were believed caused by the influx of radioactive particles from sources other than Hanford. Non-volatile emitter measurements prior to November 10 were on the order of 3×10^{-5} μc/g and during the remainder of the quarter were on the order of 5×10^{-5} to 5×10^{-4} μc/g. The activity density from alpha particle emitters ranged from 1 to 3×10^{-7} μc/g near the separation areas and averaged less than 5×10^{-8} μc/g at the project perimeter.

SECTION III - RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE:

Radiation dosage rates evaluated from ionization chamber readings averaged 1 mrep/day near the separation areas and 0.7 mrep/day at the project perimeter. Increases in the activity density from filterable beta particle emitters were observed after November 10 when the number of radioactive particles increased significantly throughout the Pacific Northwest with the activity density from these emitters averaging between 1.3×10^{-13} μc/cc and 5×10^{-12} μc/cc near the separation areas and averaging between $< 4 \times 10^{-14}$ μc/cc and 3.0×10^{-13} μc/cc at perimeter locations. The maximum measurement obtained over a one week period was 3.7×10^{-11} μc/cc near the Redox area. The number of radioactive particles at locations near the separation areas increased from values on the order of 2×10^{-2} particle/m^3 prior to November 10, to values of 0.6 and 1.6 particles/m^3 on November 10 and November 11. Off-site monitors showed concentrations ranging from 0.3 to 1.7 particles/m^3 on the same dates at locations in Oregon, Idaho, and Washington. The predominance of higher values at remote locations indicated the source of these particles was probably not associated with Hanford effluents. Several comparable increases in particulate contamination were noted during late November and December. Omission of these exceptionally high findings would cause the average particulate deposition to be on the order of magnitude expected for Hanford operation. The activity density from I^{131} in the atmosphere decreased to values ranging from less than 1×10^{-13} μc/cc to

5×10^{-13} µc/cc near the separation areas and to values $< 1 \times 10^{-13}$ µc/cc at all perimeter locations. Sixteen out of 63 air samples collected during low dilution periods showed values in excess of 1×10^{-9} µc I^{131}/cc; the maximum measurement was 2.3×10^{-8} µc/cc. The average activity density from alpha particle emitters in the atmosphere ranged from 4×10^{-15} µc/cc to 2.5×10^{-14} µc/cc throughout the environs.

SECTION IV - RADIOACTIVE CONTAMINATION IN HANFORD WASTES:

The activity density from beta particle emitters in reactor effluent averaged between $2.5 \times 4.3 \times 10^{-3}$ µc/cc at the six reactor areas. Maximum concentrations on the order of 5×10^{-3} µc/cc were measured at several of the reactors during December. Twenty-seven samples collected from the 107-C basin, placed in operation on November 17, averaged 3.9×10^{-3} µc/cc including a maximum of 5.9×10^{-3} µc/cc. Samples of effluent water which were analyzed for the activity density from alpha particle emitters, plutonium, and uranium, showed average values below the detection limit of the measurement. Trace quantities of polonium were detected in one sample of 107-H water. An average of 0.28 mc I^{131}/day was discharged to the river from the Biology farm. The average activity density from I^{131} in the farm waste was 4.1×10^{-6} µc/cc including a maximum value of 2.8×10^{-5} µc/cc. Except for significant increases in the amount of contamination measured in the Redox swamp, the amounts of contamination found in waste sources in the separation areas remained on the order of magnitude expected. The average activity density from beta particle emitters in the Redox swamp water averaged 3×10^{-4} µc/cc including a maximum of 4.1×10^{-3} µc/cc; mud samples collected at the perimeter of the swamp showed values approaching 9 µc/g. Portable instrument surveys in the region showed radiation levels ranging from 5 to 550 mrep per hour around the pond perimeter; the latter values included from 1 to 70 mr/hr. No significant changes were noted in the amounts of contamination in 300 area wastes.

SECTION V - RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER:

Increases in the activity density from gross beta particle emitters observed during the latter part of the previous quarter continued during this period. A significant decrease in the flow rate of the Columbia River from an average of 976,000 gps during the previous quarter to an average of 424,000 gps during this period largely accounted for the increase in activity density. Operation of the reactors at higher power levels during the last two months of the quarter also contributed to the increase. Maximum beta particle contamination was found between the Hanford Ferry and the 100-H area where the average activity density ranged from 7×10^{-6} to 1.1×10^{-5} μc/cc; the maximum individual sample was collected below the 100-H areas and showed a value of 2.8×10^{-5} μc/cc. The average activity density from alpha particle emitters in Columbia River water was $< 5 \times 10^{-9}$ μc/cc at all locations. I^{131} in the Columbia River at the Hanford Ferry averaged 1×10^{-7} μc/cc including a maximum measurement of 2.1×10^{-7} μc/cc. Samples of mud collected from the shore of the Columbia River at various locations showed average values comparable to those previously measured. Several isolated samples collected below the 100-F and 100-H areas showed higher values which were consistent with the river monitoring results; the maximum measurement near the 100-H area was 2.8×10^{-3} μc/g. Increases in the activity density from beta particle emitters in raw water supplies by factors from 3 to 5 were caused by the decreased flow rate of the river; the average activity density ranged from 4.5×10^{-7} to 1.0×10^{-6} μc/cc at the reactor area with maximum measurements observed at the 100-H area where a value of 2.3×10^{-6} was obtained.

SECTION VI - RADIOACTIVE CONTAMINATION IN RAIN:

Increases in the activity density from beta particle emitters in rain samples were observed during the latter part of the quarter and were associated with high radioactive particle concentrations over the environs. The average activity density from beta particle emitters in rain collected in the separation areas ranged from 1 to 3 x 10^{-5} μc/cc and in samples collected at perimeter locations averaged 5 x 10^{-6} μc/cc. Maximum measurements were found in the 200 West area in samples which showed concentrations on the order of 1 to 1.6 x 10^{-4} μc/cc.

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

Trace quantities of alpha particle emitters were found in several Richland wells and in two Benton City drinking supplies. Average values ranged from 5 to 8 x 10^{-9} μc/cc at Richland and 1.2 to 1.5 x 10^{-8} μc/cc at Benton City. Uranium in these same wells averaged about 5 x 10^{-3} μg/cc at Richland and ranged from 5 x 10^{-3} to 1.3 x 10^{-2} μg/cc at Benton City. Positive indications of beta particle emitters were found in the sanitary water supplies at the Hanford operating areas and in the drinking water supplies at the Pasco Improvement Farm well, and in the Kennewick and Pasco drinking water supplies. Maximum measurements were found in the Pasco samples which averaged 1.2 x 10^{-6} μc/cc including a maximum measurement of 1.7 x 10^{-6} μc/cc. Samples of filtering media obtained from the Pasco filtering plant showed the activity density from beta particle emitters to average 2.3 x 10^{-4} μc/g on the surface of the sand and coal filters. Backwash materials from these filters showed average values ranging from 2.4 x 10^{-2} to 2.9 x 10^{-3} μc/g in the solid portion and an average of 1.3 x 10^{-4} μc/cc in the liquid portion. Samples of drinking water obtained from remote communities in Washington and Oregon showed no detectable activity from gross beta and gross alpha particle emitters.

INTRODUCTION

The extent and magnitude of radioactive contamination in the Hanford environs was determined from the measurements obtained by the Regional Survey forces of the Control Unit, Biophysics Section, Radiological Sciences Department. Radioactive contamination was measured by radiochemical analysis of liquid, solid and gaseous samples collected from the environs and by recorded and direct readings obtained with fixed and portable instruments.

Monitoring methods employed during October, November and December were identical to those described in previous documents of this series (HW-23133, HW-24203, HW-25866 and HW-27510). Analytical procedures used by the Control Laboratory for radiochemical analysis are detailed in HW-20136. Correction factors applied to the counting rates of prepared samples are summarized in HW-22682, HW-23769 and HW-27584. Decay corrections were applied to measurements for specific isotopes and to selected gross beta particle measurements which contained a predominance of short half-life emitters.

The location of monitoring stations and sampling locations referred to in the discussion may be identified from a series of maps included in HW-25866 and HW-21214. Project boundaries indicated on these maps are those defined by the United States Atomic Energy Commission on drawing SK-7-414.

SECTION I

RADIOACTIVE CONTAMINATION IN EFFLUENT GASES

The amount of radioactive contamination discharged to the atmosphere from the separation areas was measured daily or weekly at all operating facilities. Samples were collected from the 50 or 20 foot level of the stacks. Contributions to the total effluent activity from air passing through the sand filters were determined by monitoring the outlet of the sand filters. Spot measurements were also taken at the inlet of the sand filter to determine its efficiency.

Total I^{131} emission from all facilities averaged 1.4 curies per day during the period. Ruthenium emission from the Redox stack averaged less than 0.1 curie per day with a maximum measurement of 0.6 curie per day occurring during October. The following discussions summarize the specific emission data for each of the separation facilities.

200 WEST AREA - T-PLANT STACK

Table I summarizes the results obtained from daily I^{131} monitoring at the T-Plant facility.

TABLE I
SUMMARY OF RESULTS FROM STACK MONITORING
T-PLANT STACK
OCTOBER, NOVEMBER, DECEMBER
1952

Month	Curies of I^{131} Dissolved Per 24 Hrs. Maximum	Curies of I^{131} Dissolved Per 24 Hrs. Average	Curies of I^{131} Emitted Daily Maximum	Curies of I^{131} Emitted Daily Average
October	620	48	0.09	0.03
November	280	40	0.5	0.1
December	2530	430	2.2	0.8
Quarter	2530	170	2.2	0.3
Last Quarter	1220	180	3.2	0.7

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A 50 per cent decrease in I^{131} emission at the T-Plant was partially caused by an increase in the average cooling time of the irradiated uranium processed. The cooling period averaged 66 days during the present quarter as compared to an average of 62 days during the previous quarter. Due to a relative light production schedule during the first two months of the quarter, the bulk of the I^{131} emission from the T-Plant occurred during the month of December.

200 WEST AREA - REDOX STACK

The results obtained from I^{131} monitoring at the Redox facility are summarized in Table II.

TABLE II
SUMMARY OF RESULTS FROM I^{131} MONITORING
REDOX FACILITY
OCTOBER, NOVEMBER, DECEMBER
1952

Month	Curies of I^{131} Dissolved per 24 Hrs.		Curies of I^{131} Emitted Daily		I^{131} Emitted Through Sand Filter Units of 10^{-4} c/day	
	Maximum	Average	Maximum	Average	Maximum	Average
October	560	180	5.2	1.4	7.1	1.6
November	720	200	1.0	0.6	2.6	1.3
December	320	90	2.6	1.2	4.9	1.7
Quarter	720	160	5.2	1.1	7.1	1.5
Last Quarter	810	195	16.4	2.4	22	5.8

The average emission of 1.1 curies of I^{131} per day represented a significant decrease in the amount of I^{131} emitted to the atmosphere when compared to the total emission from this facility since the start-up of the operation during early 1952. The decrease reflects the increase in the cooling time of the irradiated metal as well as the absence of silver reactor failures and improved operation. The magnitude of the decrease in

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I^{131} emission was also weighted by exceptionally high emission during the previous quarter when the B-cell silver reactor failed over a prolonged period during August.

Table III summarizes the results obtained from monitoring for ruthenium at the Redox Stack.

TABLE III
SUMMARY OF RESULTS FROM RUTHENIUM MONITORING
REDOX STACK
OCTOBER, NOVEMBER, DECEMBER
1952

Month	Ruthenium (Ru^{103} + Ru^{106}) Emitted units of curie/day Maximum	Average
October	0.58	0.07
November	0.36	0.09
December	0.55	0.02
Quarter	0.58	0.04
Last Quarter	4.1	0.23

Ruthenium emission from the Redox facility was the lowest ever measured since the start-up of the Redox process in January, 1952. The absence of unusual instances, which caused high ruthenium emission over one or two day periods in each of the past quarters, contributed significantly to the low average emission measured during this period.

Table IV summarizes the results obtained from daily measurements performed on filters which were removed from the upstream side of the sand filter at the Redox facility. These measurements were initiated early in November at the request of the Atomic Energy Commission in an effort to determine the amount of contamination passing to the sand filter.

TABLE IV
SUMMARY OF FILTER MEASUREMENTS
UPSTREAM OF REDOX SAND FILTER
OCTOBER, NOVEMBER, DECEMBER
1952

Week Ending	C.P. Meter Readings 10^{-3} mrep/hr per ft^3 of Gas		Particles per ft^3 of Gas	
	Maximum	Average	Maximum	Average
11-1-52	1.8	0.6	0.64	0.38
11-8-52	3.6	2.0	0.36	0.17
11-15-52	3.6	2.1	0.44	0.21
11-22-52	1.8	0.7	0.32	0.20
11-29-52	32	13	0.22	0.19
12-6-52	16	4.3	0.65	0.46
12-13-52	270	53	0.37	0.26
12-20-52	17	9.0	0.48	0.27
Quarter	270	11	0.64	0.26

The number of radioactive particles was determined by radioautographing the air filters using type K X-ray film for a period of 168 hours and visually counting the number of darkened areas on the developed film. As the above measurements represent initial attempts at this type of monitoring, these data cannot be compared to previous measurements.

Air filter samples were obtained at the downstream side of the sand filter during periods corresponding to those indicated in Table IV. Instrument readings on these filters using a VGM were less than 100 c/m on all filters removed. Except for one or two isolated cases where two particles were detected by the radioautographic process, particulate contamination on the downstream air filter samples was negligible.

200 WEST AREA TBP PLANT STACK

The results obtained from measurements for filterable gross alpha and gross beta particle emitters discharged from the 291-U stack are presented in Table V.

TABLE V
SUMMARY OF FILTER MEASUREMENTS
TBP PLANT STACK
OCTOBER, NOVEMBER, DECEMBER
1952

Curie Emitted Per Day

Month	Total Alpha Particle Emitters		Total Beta Particle Emitters	
	Maximum	Average	Maximum	Average
October	3.4×10^{-7}	5.7×10^{-8}	1.8×10^{-6}	9.7×10^{-7}
November	2.5×10^{-8}	1.4×10^{-8}	1.5×10^{-4}	1.9×10^{-5}
December	6.8×10^{-8}	2.6×10^{-8}	8.1×10^{-6}	3.6×10^{-6}
Quarter	3.4×10^{-7}	3.3×10^{-8}	1.5×10^{-4}	8.7×10^{-6}
Last Quarter	4.8×10^{-7}	1.2×10^{-7}	7.7×10^{-6}	8.2×10^{-7}

The general increase in the activity density from beta particle emitters detected in the effluent during November coincided with increased operations at the TBP facility.

Several spot filter samples collected over a seven day period at the TBP Stack were radioautographed to determine the magnitude of particulate contamination emanating from this facility. Total particles on these filters ranged from 0 to 2, indicating negligible particulate emission from this operation.

100 AREAS REACTOR STACKS.

The amount of C^{14}, S^{35}, tritium oxide, radioactive particles, and gross alpha and gross beta particle emitters discharged from the reactor stacks was determined from samples obtained from the 105 stacks. Tables VI through IX summarize the results of these measurements at the 100-F, 100-D, 100-DR, and 100-H Areas.

TABLE VI
SUMMARY OF ACTIVITY MEASUREMENTS
105-F STACK
OCTOBER, NOVEMBER, DECEMBER
1952

Month	Curies Emitted Per 24 Hours					Radioactive Particles
	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Total Alpha Units of 10^{-6}	Total Beta Units of 10^{-4}	10^5 Ptls/Day
October						
Maximum	0.22	-	< 8	4.5	7.0	5.0
Average	0.10	*	< 8	1.9	3.8	1.6
November						
Maximum	0.37	-	< 8	1.7	11.2	18.4**
Average	0.09	*	< 8	1.0	4.9	18.4
December						
Maximum	0.41	< 6	< 8	9.7	0.6	0.81**
Average	0.13	< 6	< 8	0.4	0.5	0.81
Quarter						
Maximum	0.41	< 6	< 8	9.7	11.2	18.4
Average	0.10	< 6	< 8	1.1	3.4	4.8
Last Quarter						
Maximum	0.61	7.3	< 8	0.4	1.8	22.8
Average	0.10	< 6	< 8	0.2	1.5	8.0

* The laboratory results for the C^{14} analyses during October and November were questionable.

** One measurement this month.

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TABLE VII
SUMMARY OF ACTIVITY MEASUREMENTS
105-D STACK
OCTOBER, NOVEMBER, DECEMBER
1952

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Total Alpha Units of 10^{-6}	Total Beta Units of 10^{-4}	Radioactive Particles 10^5 Ptls/Day
	Curies Emitted Per 24 Hours					
October						
Maximum	0.29	-	< 8	0.39	18.2	<8
Average	0.07	*	< 8	0.24	6.7	<0.3
November						
Maximum	0.28	-	< 8	0.80	166	21.5**
Average	0.10	*	< 8	0.47	85	21.5
December						
Maximum	0.55	< 6	< 8	0.34	198	-
Average	0.12	< 6	< 8	0.20	91	-
Quarter						
Maximum	0.55	< 6	< 8	0.80	198	21.5
Average	0.10	< 6	< 8	0.31	70	5.3
Last Quarter						
Maximum	0.31	< 6	< 8	0.11	4.7	8.1
Average	0.10	< 6	< 8	0.02	1.7	1.4

* The laboratory results for the C^{14} analyses during October and November were questionable.

** One measurement this month.

TABLE VIII

SUMMARY OF ACTIVITY MEASUREMENTS

105-DR STACK

OCTOBER, NOVEMBER, DECEMBER

1952

Month	Curies Emitted Per 24 Hours: Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Total Alpha Units of 10^{-6}	Total Beta Units of 10^{-4}	Radioactive Particles 10^5 Ptls/Day
October						
Maximum	0.12	-	< 8	0.69	0.05	< 0.8
Average	0.03	*	< 8	0.43	0.03	< 0.2
November						
Maximum	0.13	-	< 8	0.41	0.13	< 0.8**
Average	0.06	*	< 8	0.22	0.05	< 0.8
December						
Maximum	0.14	< 6	< 8	1.1	0.03	< 0.8**
Average	0.06	< 6	< 8	0.47	0.02	< 0.8
Quarter						
Maximum	0.14	< 6	< 8	1.1	0.13	< 0.8
Average	0.05	< 6	< 8	0.37	0.04	< 0.1
Last Quarter						
Maximum	0.36	14.3	< 8	0.03	0.1	0.8
Average	0.07	< 6	< 8	<0.001	0.008	0.3

* The laboratory results for the C^{14} analyses during October and November were questionable.

** One measurement this month

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TABLE IX

SUMMARY OF ACTIVITY MEASUREMENTS

105-H STACK

OCTOBER, NOVEMBER, DECEMBER

1952

Month	Tritium Oxide	C^{14} Units of 10^{-3}	S^{35} Units of 10^{-4}	Total Alpha Units of 10^{-6}	Total Beta Units of 10^{-4}	Radioactive Particles 10^5 Ptls/Day
	Curies Emitted Per 24 Hours					
October						
Maximum	0.33	-	< 8	5.5	0.48	4.1
Average	0.08	*	< 8	2.4	0.41	1.8
November						
Maximum	0.08	-	< 8	1.5	3.6	0.8**
Average	0.03	*	< 8	0.6	1.7	0.8
December						
Maximum	0.09	≤ 6	< 8	7.7	0.42	0.8**
Average	0.04	< 6	< 8	0.5	0.12	0.8
Quarter						
Maximum	0.33	≤ 6	< 8	7.7	3.6	4.1
Average	0.05	< 6	< 8	1.1	0.94	1.5
Last Quarter						
Maximum	0.32	< 6	< 8	1.0	0.84	6.4
Average	0.06	< 6	< 8	0.2	0.41	4.1

* The laboratory results for the C^{14} analyses during October and November were questionable.

** One measurement this month.

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Increases in the number of radioactive particles and in the activity density of gross beta and alpha particle emitters in the 105-D effluent gases were associated with leaks in the waste drain carrying the drier room condensate. Several high measurements were noted at this facility during the previous quarter and the current increase was a continuation of this trend. Increases in the average activity density from total alpha and total beta particle emitters at the other reactors appeared to follow general increases in the power levels at which the reactors were operated.

Amounts of tritium oxide and S^{35} leaving the reactor stacks were comparable to those observed during previous monitoring periods. Although many of the C^{14} measurements were deleted from the data because of fission product interference during the laboratory analysis, the data did not indicate a repetition of the two positive C^{14} measurements obtained at the 100-F and 100-DR Areas during the previous quarter.

Estimation of the amount of argon (A[illegible]) leaving the reactors was made at selected locations during this period. Air samples were collected in a 500 cc ionization chamber after the gas had been scrubbed through a barium hydroxide solution. The counting rates of the collected samples were determined by measuring ionization in the chamber with a vibrating reed electrometer. Decay studies performed on a number of the samples indicated a 110 minute half-life, identifying argon as the major component. Eight measurements at the 105-H reactor, during periods in which the reactors were operated at normal power levels, indicated average activity density from argon on the order of 10^{-5} μc/cc; the maximum measurement was 7×10^{-5} μc/cc. Eleven measurements at the 105-DR stack showed an average of 7×10^{-5} μc/cc, including a maximum of 1×10^{-4} μc/cc. Four measurements at 105-D averaged 2×10^{-5} μc/cc with a maximum of 3×10^{-5} μc/cc.

Several spot estimates of the amount of long half-life activity present in the reactor gas were obtained by collecting and analyzing samples in a manner similar to that described for the argon measurements but eliminating the barium hydroxide scrubbing. The activity in these samples gave values of $< 4.5 \times 10^{-6}$ μc/cc of sample collected. The latter value was on the conservative side, as the ionization in the sample chamber was equal to background after 24 hours. The value of 4.5×10^{-6} μc/cc was used as the sensitivity level of the argon measurements.

SECTION II

RADIOACTIVE CONTAMINATION ON VEGETATION

Over 1800 samples of vegetation were collected from locations on and immediately adjacent to the Hanford Works and nearly 700 samples were collected from locations in the states of Washington, Idaho, and Oregon to determine the gross deposition of beta particle emitters on vegetation. All samples were analyzed specifically for the activity from I^{131}; nearly one-half of the samples from the immediate environs and all samples from remote locations were also analyzed for the activity density from non-volatile beta particle emitters. Weekly samples from selected locations in the immediate environs were analyzed for the activity from gross alpha particle emitters.

Table I summarizes the results obtained from the measurements for the activity from I^{131} and from non-volatile beta particle emitters during the three month period; previous quarterly averages are included for comparison.

Increases in the amount of I^{131} deposited in many locations in the immediate environs were influenced by undesirable meteorlogical conditions which caused low dilution of the stack effluent. The contributing cause tended to prevail toward the latter part of the quarter; average I^{131} deposition during the month of October was comparable to that observed during the latter part of the previous quarter and the values were among the lowest measured since the start-up of the Hanford operation. The significance of the increase in I^{131} deposition during the quarter may be appraised from data summarized in Table II which shows the month to month trend of the average deposition.

TABLE I
RADIOACTIVE CONTAMINATION ON VEGETATION
4TH QUARTER
1952

Location	No. Samples	I^{131} Units of 10^{-6} µc/g Max.	Avg.	Last Qtr. Avg.	Non-Volatile Emitters Units of 10^{-6} µc/g Max.	Avg.	Last Qtr. Avg.
North of 200 Areas	194	28	5	< 3	150	53	27
Near the 200 Areas	161	61	7	< 3	500	70	35
Route 3	13	39	13	4	70	40	
200 West Gate	123	120	20	8	540	83	32
200 East Tower #16	124	100	8	3	940	77	32
Batch Plant	49	130	13	5	180	67	37
Meteorology Tower	13	32	11	4	61	55	
South of 200 Areas	308	34	5	< 3	570	64	29
Richland	169	41	4	< 3	240	49	31
Pasco Environs	76	36	3	< 3	370	50	35
Kennewick Environs	115	84	5	< 3	230	42	27
Benton City - Kiona	40	13	< 3	< 3	180	47	77
Richland "Y"	13	16	< 3	4	32	32	
Hanford	24	15	3	< 3	47	25	30
200 East Area	47	24	6	3	130	50	28
200 West Area	66	100	21	6	1900	110	29
Redox Area	90	75	15	8	33	33	
Wahluke Slope	60	7	< 3	< 3	92	28	36
Goose Egg Hill	61	28	7	< 3	330	56	38
Rattlesnake Mountain	38	32	8	< 3	440	116	24
PSN-300 - 310-330	39	72	12	3	84	60	
Total on Area	1823						
Off-Area Sampling							
Pasco to Ringold	75	14	< 3	< 3	120	31	29
Prosser to Patterson - McNary	247	20	< 3	< 3	340	42	27
Eastern Washington	197	54	4	< 3	380	47	21
So. Washington and No. Oregon	150	10	< 3	< 3	260	31	19
Yakima Barricade to Ellensburg	13		—		680	280	
Total Vegetation Samples	2505						

TABLE II
ACTIVITY DENSITY FROM I^{131} ON VEGETATION
OCTOBER, NOVEMBER, DECEMBER
1952

Units of 10^{-6} μc/g

Location	October Max.	October Avg.	November Max.	November Avg.	December Max.	December Avg.
North of 200 Area	6	< 3	21	8	28	9
North 200 Areas	7	< 3	52	8	61	13
Route 3	3	< 3	39	15	39	22
200 West Gate	6	< 3	37	13	120	46
200 East Tower #16	8	< 3	59	< 3	100	13
Batch Plant	130	9	18	7	64	24
Meteorology Tower	3	< 3	21	12	32	23
South of 200 Areas	24	< 3	24	9	34	10
Richland	7	< 3	29	6	41	7
Pasco Environs	3	< 3	36	5	10	5
Kennewick Environs	7	< 3	32	4	84	7
Benton City - Kiona	13	< 3	11	3	8	5
Richland "Y"	3	< 3	16	4	< 3	< 3
Hanford	5	< 3	15	5	8	4
200 East Area	5	< 3	13	4	24	14
200 West Area	28	< 3	7	4	100	56
Redox Const. Area	7	< 3	66	11	75	22
Wahluke Slope	< 3	< 3	7	< 3	< 3	< 3
Goose Egg Hill	3	< 3	20	< 3	28	18
Rattlesnake Mountain					32	8
PSN-300-310-320	6	< 3	21	8	72	27
<u>Off Area Sampling</u>						
Pasco to Ringold	4	< 3	14	< 3	11	5
Prosser to Patterson-McNary	11	< 3	20	4	15	4
Eastern Washington	54	< 3	30	8	6	< 3
South Washington and North Oregon	5	< 3	8	< 3	10	< 3
Yakima Barricade to Ellensburg	--	---	--	--	--	--

As indicated in Figure 1, which is an estimated iso-activity map showing the I^{131} deposition during October, the only areas at which positive amounts of I^{131} were found were located in the region due southeast of the separation facilities. These observations correlated favorably with prevailing wind directions measured at the meteorology station near the 200 West Area. Although most of the places at which I^{131} was detected were confined to random areas on the order of 1 sq. mile each, it was interesting to note that deposition in the populated area of Kennewick and Richland covered a larger area than that in which I^{131} was detected near the separation facilities. The deposition pattern during November (Figure 2) shows the same random deposition along with a general increase in the size of the areas in which I^{131} was detected. Again, the populated regions of Kennewick and Richland show areas of positive activity comparable to those in the immediate vicinity of the separation facilities. Deposition during the month of December shows increases to values in the range of 2.5×10^{-5} to 1.0×10^{-4} μc/g predominating in and around the 200 West areas and values in excess of 5×10^{-6} μc/g over elongated regions extending northwest and southeast over the entire project.

A composite isoactivity map showing the I^{131} deposition based on all samples collected during the three month period is presented in Figure 4. Table III summarizes the results obtained from analyzing vegetation samples which were collected at remote locations.

Small increases in the amount of I^{131} detected on vegetation from off-site locations were observed during the latter part of the quarter. Average deposition during October was less than 3×10^{-6} μc/g in nearly every sample analyzed; the lower values were a continuation of a trend observed during the previous quarter. Higher measurements during November and December correlated favorably with increases noted in the immediate environs during the same period.

TABLE III

RADIOACTIVE CONTAMINATION ON VEGETATION

OFF AREA LOCATIONS

OCTOBER, NOVEMBER, DECEMBER

1952

Units of 10^{-6} μc/g

Location	I^{131} No. Samples	I^{131} Maximum	I^{131} Average	Non-Volatile Emitters Maximum	Non-Volatile Emitters Average
Stanfield	2	< 3	< 3	18	16
Meacham	2	< 3	< 3	22	21
Pendleton	4	5	< 3	28	24
Hermiston	2	< 3	< 3	22	18
Wallula	10	21	6	120	55
Touchet	6	54	13	33	20
Louden	5	8	4	23	17
Walla Walla	12	6	3	61	32
Dixie	6	8	3	31	23
Waitsburg	11	16	5	110	39
Dayton	12	9	< 3	79	36
Pomeroy	11	9	3	56	29
Lewiston	12	21	6	380	120
Uniontown	4	5	< 3	38	26
Pullman	11	7	3	180	60
Colfax	10	11	< 3	58	37
Steptoe	5	10	4	25	24
Rosalia	6	7	3	50	31
Spokane	11	17	< 3	130	39
Cheney	11	7	< 3	160	44
Sprague	11	7	< 3	160	50
Ritzville	10	11	< 3	64	34
Lind	11	30	7	250	73
Connell	11	12	< 3	67	21
Yakima Barricade to Yakima	5	--	--	680	480
Moxee City	4	--	--	420	220
Yakima City	4	--	--	140	96
Moxee	8	5	< 3	38	24
Union Gap	4	< 3	< 3	30	17
Wapato	8	10	< 3	70	30
Toppenish	8	5	< 3	140	37
Toppenish to Goldendale	18	8	< 3	110	28
Goldendale	8	4	< 3	200	49

TABLE III (contd.)

Units of 10^{-6} μc/g

Location	I^{131} No. Samples	I^{131} Maximum	I^{131} Average	Non-Volatile Emitters Maximum	Non-Volatile Emitters Average
Goldendale to Wishram	6	7	< 3	21	18
Lyle	4	< 3	< 3	80	37
Bingen	4	< 3	< 3	20	12
Camas	8	5	< 3	57	23
Vancouver	8	3	< 3	100	36
Portland	8	4	< 3	74	29
Troutdale	4	< 3	< 3	56	40
Bonneville	4	3	< 3	48	20
Hood River	4	4	< 3	28	14
The Dalles	8	3	< 3	110	32
Moody	4	4	< 3	260	96
Rufus	4	3	< 3	170	68
Blalock	4	< 3	< 3	66	31
Arlington	4	< 3	< 3	43	23
Heppner Junction	4	5	3	56	29
Boardman	4	7	4	68	33
Umatilla	4	3	< 3	66	32

The activity density from non-volatile beta particle emitters increased by about a factor of 2 during this quarter (Table I and Table III). Non-volatile activity measurements obtained prior to November 10 show values which were nearly identical to those observed during this previous three month period. Samples collected after November 10 showed increases in this activity from values on the order of 3×10^{-5} μc/g to values on the order of 1×10^{-4} μc/g to 5×10^{-4} μc/g. This increase in non-volatile beta particle emitters occurred at the same time that measurements obtained from air monitoring stations showed a significant increase in particulate contamination in this region. The increase in particle concentrations apparently resulted from clouds of radioactive material which originated after the nuclear explosions which occurred during this period. In general, results obtained from off-site vegetation monitoring immediately after November 10, were as high or higher than those detected in the immediate environs. The activity density from non-volatile beta particle emitters on vegetation was decreasing to the order of magnitude expected from normal operations (4×10^{-5} μc/g) during the latter part of December.

Several samples of sugar beets were obtained from the Pasco Improvement Farm during early December. Analysis of these samples for the activity from total beta particle emitters showed two positive values of 1.6×10^{-5} and 2.2×10^{-5} μc/g.

The results obtained from the radiochemical analysis of vegetation samples for the activity from gross alpha particle emitters are presented in Table IV.

TABLE IV

ACTIVITY DENSITY FROM GROSS ALPHA PARTICLE EMITTERS ON VEGETATION

OCTOBER, NOVEMBER, DECEMBER

1952

Units of 10^{-8} μc/g

Location	October	November	December	Quarterly Average	Maximum Results
Near 200 Areas					
200 West Gatehouse	7	22	75	33	100
Batch Plant	11	15	61	27	70
Route 4S Mile 4	8	< 5	61	22	100
Meteorology Tower	9	12	11	11	25
Route 4S Mile 6	< 5	< 5	8	< 5	12
300 Area	38	170	110	100	190
Outlying					
Richland	< 5	< 5	6	≤ 5	7
Pasco	< 5	< 5	5	≤ 5	10
Benton City	< 5	< 5	< 5	< 5	5

Considerable fluctuation in the activity density from alpha particle emitters on vegetation was observed throughout the three month period. Average values in the range of 1×10^{-7} μc/g to 3×10^{-7} μc/g in the immediate environs of the separation areas were nearly identical to the results of similar measurements obtained during the previous quarter.

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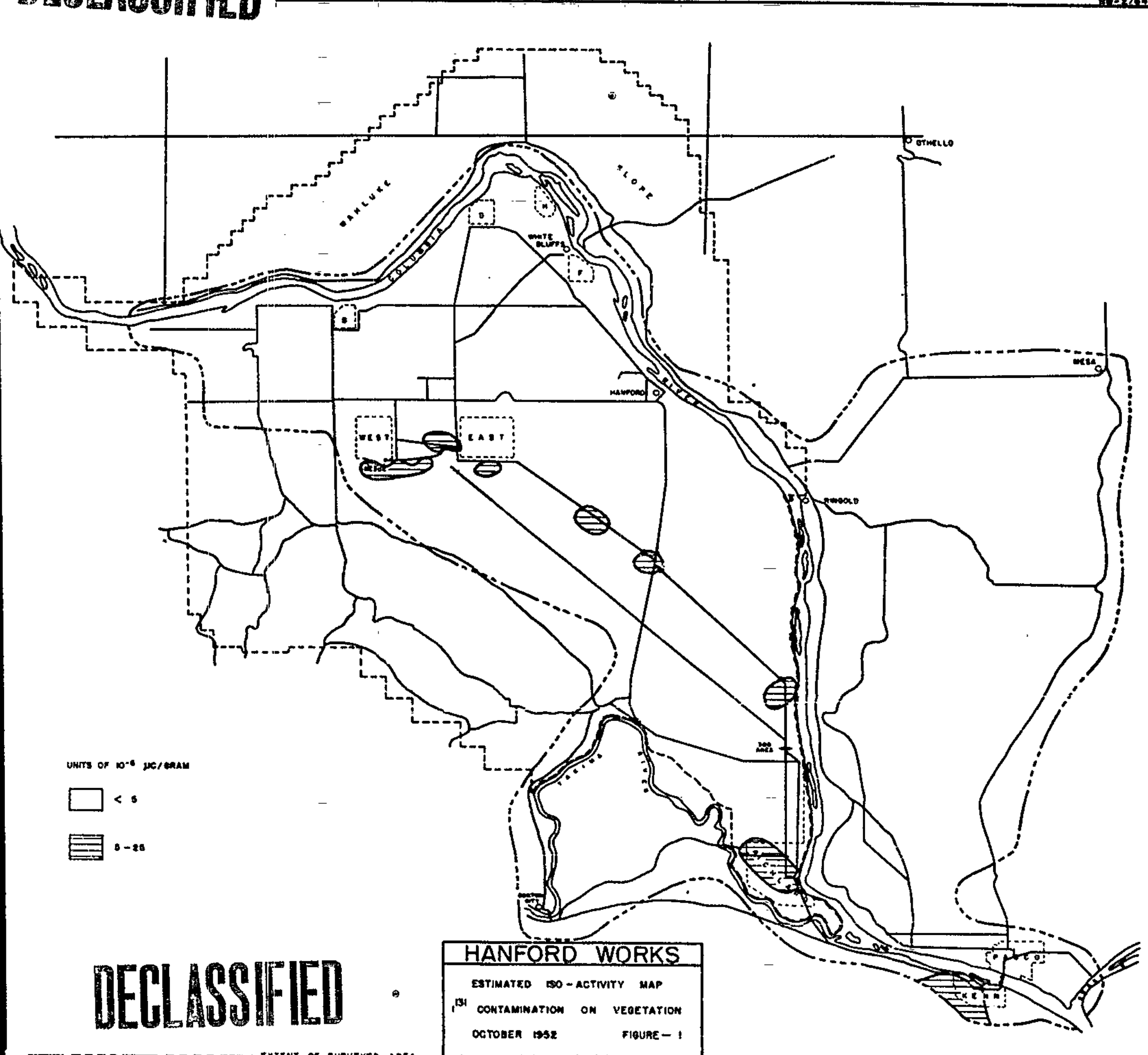

HANFORD WORKS

ESTIMATED ISO-ACTIVITY MAP

I[131] CONTAMINATION ON VEGETATION

OCTOBER 1952 FIGURE—1

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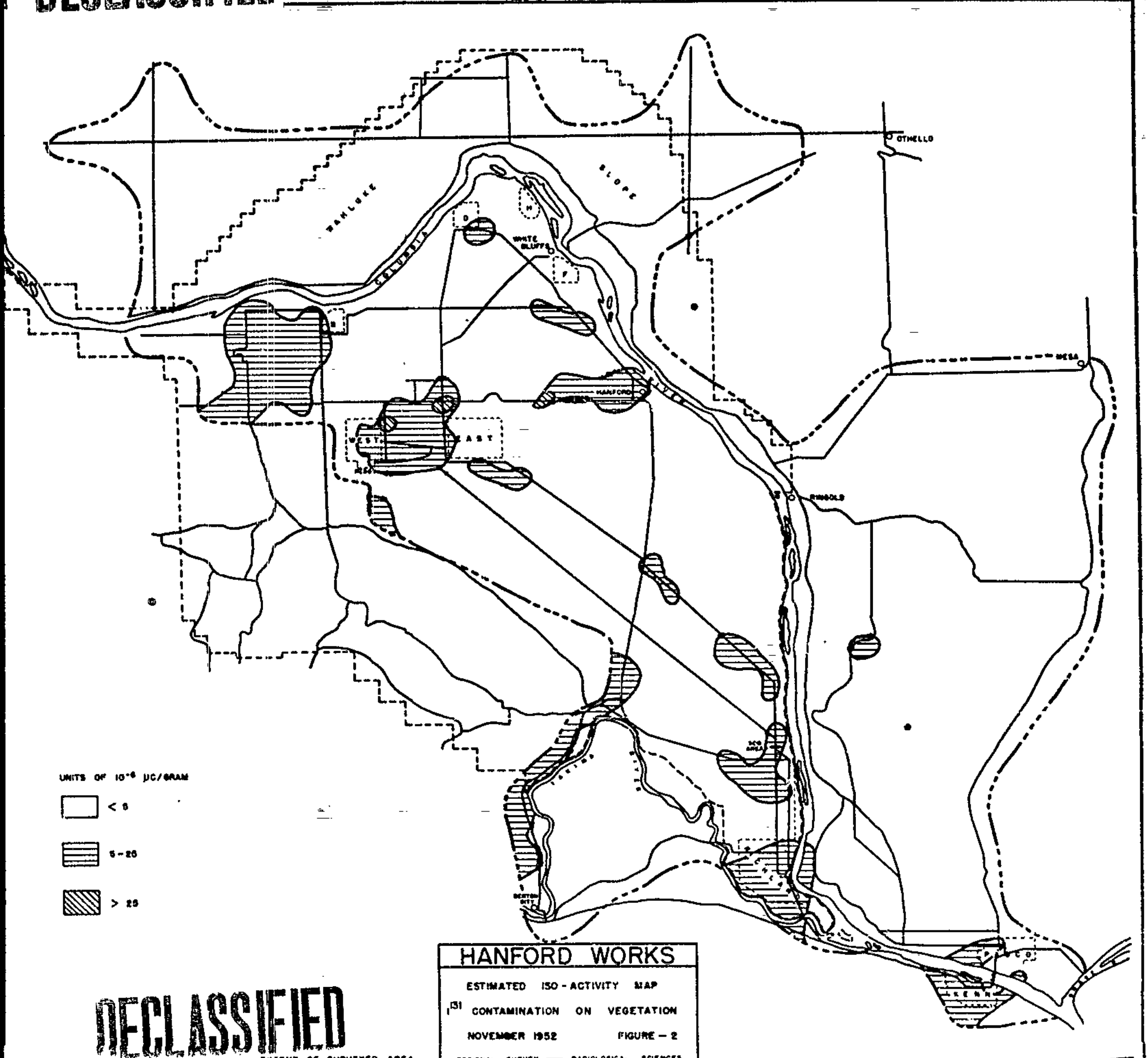

HANFORD WORKS

ESTIMATED ISO - ACTIVITY MAP

I^{131} CONTAMINATION ON VEGETATION

NOVEMBER 1952 FIGURE — 2

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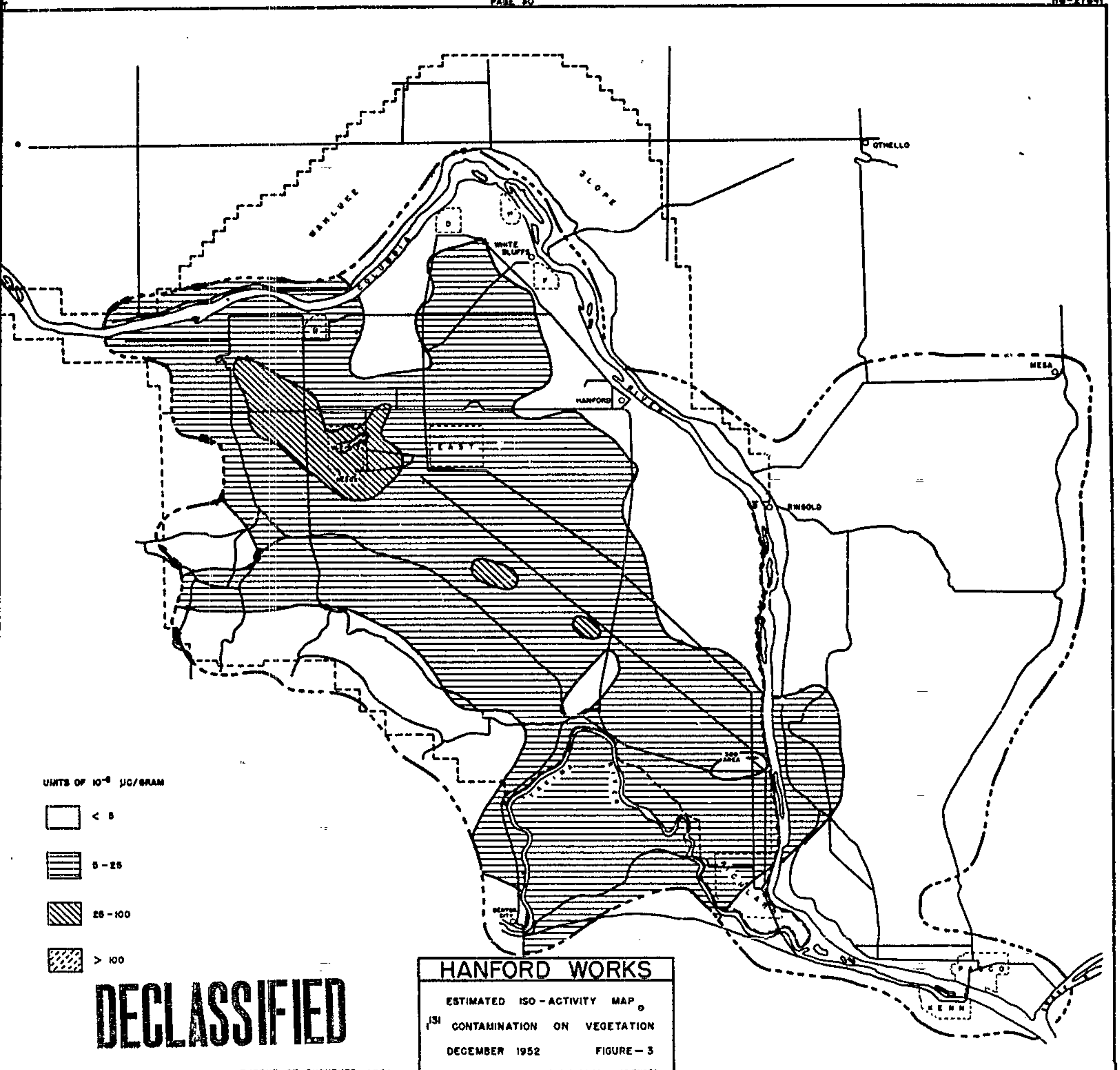
OTHELLO
WAHLUKE
SLOPE
COLUMBIA
WHITE BLUFFS
HANFORD
RIVER
EAST
RINGOLD
MESA
300 AREA
BENTON CITY
PASCO
KENN
UNITS OF 10^{-6} µC/GRAM
< 5
5 - 25
25 - 100
> 100
EXTENT OF SURVEYED AREA
HANFORD WORKS
ESTIMATED ISO-ACTIVITY MAP
I^{131} CONTAMINATION ON VEGETATION
DECEMBER 1952 FIGURE — 3
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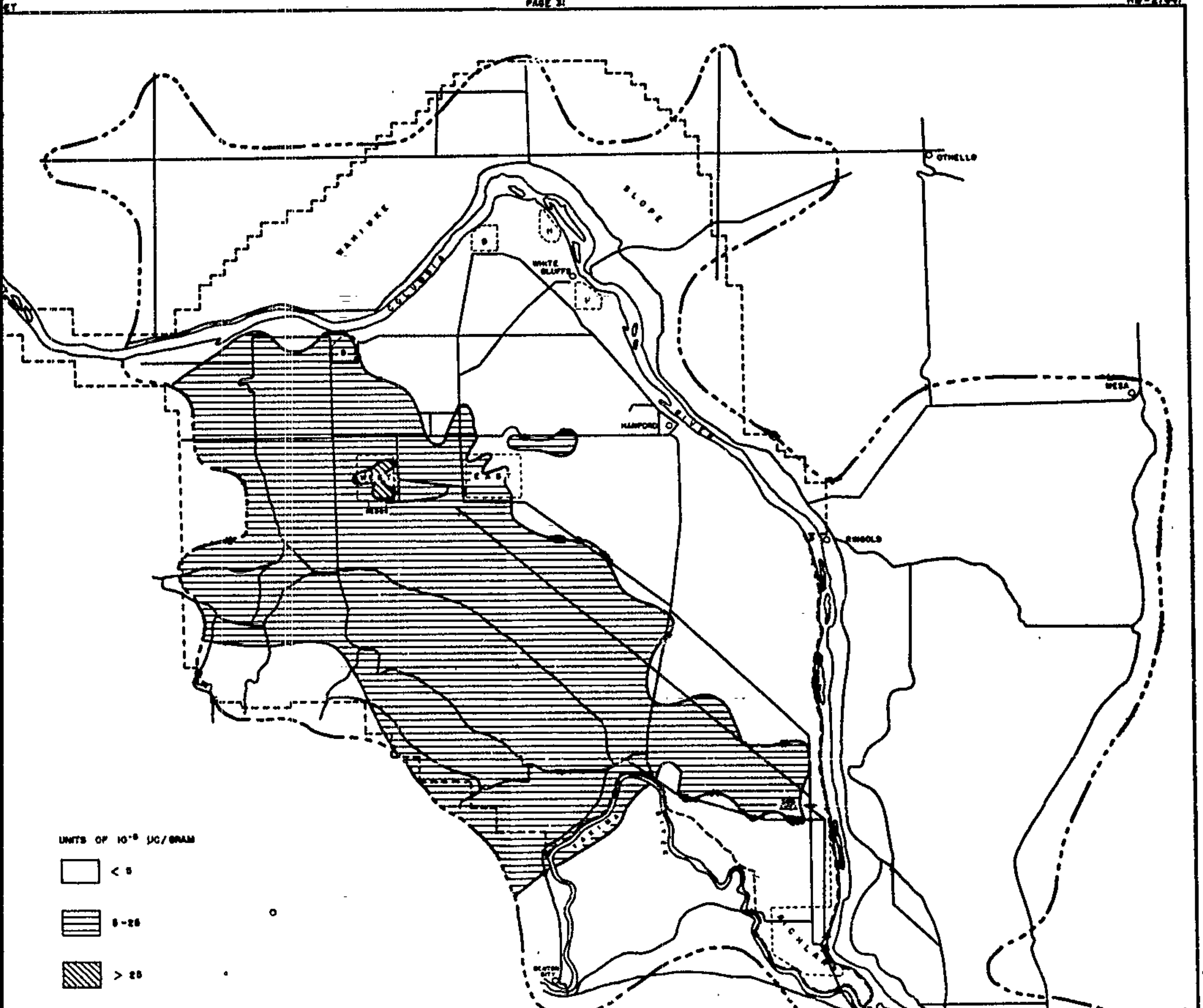

HANFORD WORKS

ESTIMATED ISO - ACTIVITY MAP

I^{131} CONTAMINATION ON VEGETATION

OCTOBER — NOVEMBER — DECEMBER

1952 FIGURE - 4

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SECTION III

RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

Atmospheric dosage rates were determined by evaluating data recorded from the operation of Victoreen integrons and C, M, and S type ionization chambers which were located in the various production areas and in the residential communities near the project. Dosage rates measured by the integrons were tabulated for each eight hour interval during the quarter; the results summarized in Table I represent the average dosage rate tabulated from these accumulated readings.

TABLE I

AVERAGE DOSAGE RATES AS MEASURED BY VICTOREEN INTEGRONS

OCTOBER, NOVEMBER, DECEMBER

1952

Location	No. of Integrons	Units of mrep per 24 hours			
		Oct.	Nov.	Dec.	Quarterly Average
100-B Area	3	0.8	0.7	0.7	0.7
100-D Area	3	0.8	0.5	0.2	0.5
100-F Area	3	0.6	0.9	0.9	0.8
100-H Area	3	0.5	0.5	0.5	0.5
200 West Area	2	0.9	0.4	0.2	0.5
200 East Area	4	2.3	0.7	0.6	1.2
Riverland	1	0.7	0.4	0.6	0.6
300 Area	1	1.2	<0.1	0.1	<0.5
Richland	1	0.9	1.1	0.5	0.8
Pasco	1	1.0	0.8	0.1	0.6
Benton City	1	1.3	1.6	0.8	1.2
North Richland North	1	0.2	<0.1	0.1	<0.2
North Richland South	1	<0.1	<0.1	<0.1	<0.1
Hanford	1	0.3	0.4	0.1	0.3
Kennewick	1	0.5	0.8	2.4	1.2
Redox	1	0.6	0.6	0.5	0.6

A comparison of these data with similar measurements obtained during the previous quarter show that the average airborne radiation levels decreased at 12 of the 15 locations. In general, this decrease was on the order of 0.2 to 0.3 mrep/day. Reductions in the amount of I^{131}, Ru^{103} and Ru^{106} discharged to the atmosphere from the separation facilities during this quarter appeared to contribute significantly to the decrease in average dosage rates.

Additional evaluations of the average dosage rate at the air monitoring stations were obtained by exposing "C" type ionization chambers at each location. Two chambers were used at each installation and the dosage was evaluated from the chamber which showed the minimum discharge. Table II summarizes the results of these findings.

TABLE II
"C" TYPE DETACHABLE IONIZATION CHAMBERS
OCTOBER, NOVEMBER, DECEMBER
1952

Location	October	November	December	Quarterly Average
	Units of mrep per 24 hours			
Within				
100-B Area	0.4	0.5	0.4	0.4
100-D Area	0.5	0.6	0.5	0.5
100-F Area	0.4	0.6	0.4	0.5
200 West Area	0.5	0.8	0.4	0.6
200 East Area	0.7	0.6	0.6	0.6

The dosage rates indicated by the "C" chamber readings were not significantly different from those observed during the first nine months of 1952. A comparison of these data on a month to month basis within the present quarter, was not indicative of any trend or change within this period.

Dosage rate monitoring at intermediate locations was accomplished by exposing detachable "M" and "S" type ionization chambers. Battery-powered minometers were used to charge and evaluate the discharge of these instruments. Again, two chambers were employed at each location and the minimum discharge was used for evaluating the dosage rate. The results of these measurements obtained during the quarter are presented in Table III.

TABLE III
RADIATION LEVELS OBSERVED WITH
"M" AND "S" TYPE DETACHABLE IONIZATION CHAMBERS
OCTOBER, NOVEMBER, DECEMBER
1952

Units of mrep per 24 hours

Location	Oct.	Nov.	Dec.	Quarterly Average	Group Average
100 Areas and Environs					
Route 1, Mile 8	0.60	0.61	0.89	0.70	
Route 2N, Mile 10	0.55	0.60	0.48	0.54	
Route 2N, Mile 5	0.46	0.51	0.68	0.55	
At White Bluffs	0.51	0.52	0.53	0.52	
Route 11-A, Mile 1	0.60	0.86	2.36	1.27	
Hanford 614 Bldg.	0.40	0.45	0.76	0.54	
Intersection Rt. 1 and Rt. 4N	0.57	0.47	0.65	0.56	0.62
At Hanford 101 Bldg.	0.47	0.51	0.53	0.50	
100-H Area	0.56	0.63	0.54	0.58	
P-11 Area	0.46	0.54	0.55	0.52	
100-B NE Construction	0.59	0.75	0.75	0.70	
100-B SE Construction	0.51	0.47	0.43	0.47	
Within 5 Miles of 200 East Area					
Route 4S, Mile 6	0.67	0.73	0.94	0.78	
Batch Plant	0.43	0.64	0.62	0.56	
Route 11-A, Mile 6	0.74	0.71	1.06	0.84	
Route 3, Mile 1	3.30	1.22	0.83	1.78	
Meteorology 200'	0.67	0.20	0.15	0.34	
Route 4S, Mile 2.5	1.04	0.90	1.37	1.10	
Redox Area	1.07	1.43	0.69	1.06	1.05
Route 4S, Mile 4.5	3.28	0.82	0.62	1.57	
Semiworks #1	1.25	0.48	0.80	0.84	
Semiworks #2	1.52	0.80	1.36	1.23	
Military Camp PSN 300	1.25	0.65	1.41	1.10	

TABLE III (contd.)

Units of mrep per 24 hours

Location	Oct.	Nov.	Dec.	Quarterly Average	Group Average
Within 5 Miles of 200 East Area (contd.)					
Military Camp PSN 310	1.02	0.70	0.63	0.78	
Military Camp PSN 320	1.10	0.99	0.63	0.91	
Military Camp PSN 330	1.69	1.19	1.28	1.39	
Redox Outside	1.87	0.96	1.43	1.42	
Within 10 Miles of 200 East					
Route 4S, Mile 10	0.63	2.11	1.05	1.26	
Route 10, Mile 1	0.86	1.31	1.03	1.07	
Route 10, Mile 3	0.76	0.87	0.87	0.83	0.94
Route 2S, Mile 4	0.52	0.59	0.71	0.61	
Near 300 Areas					
Route 4S, Mile 16	0.94	0.84	1.02	0.93	
Route 4S, Mile 22	0.75	0.79	0.79	0.78	
North Richland North	0.70	0.57	0.35	0.54	0.72
North Richland South	0.48	0.50	0.42	0.47	
300 Area	0.65	1.25	0.72	0.87	
Outlying					
Richland	0.67	1.39	0.95	1.00	
Benton City	0.60	1.63	0.71	0.98	
Pasco	0.49	0.41	0.53	0.48	
Kennewick	0.41	0.54	0.44	0.46	0.73

Dosage rates measured in the environs of the reactor areas, within a 5 mile radius of the separation areas, near the 300 areas, and in the outlying communities were not significantly different from those measured during the previous quarter. The average dosage rate at stations located within 10 miles of the separation areas decreased 0.22 mrep/day during this period. This decrease was largely weighted by readings which were obtained at Route 10, Mile 3, which showed a decrease from a previous average of 2.1 mrep/day to 0.8 mrep/day. This station is located directly downwind from the 202-S facility; the magnitude of decrease was associated

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with reduced emission of iodine and ruthenium at this facility during the present period.

The activity density from filterable gross beta particle emitters in the atmosphere was determined by analyzing air filters which were exposed at representative locations for periods ranging from 1 to 7 days. Intervals ranging from two to four days were allowed prior to counting the filters for decay of the daughter products of natural particle emitters. Table IV summarizes the results obtained from these measurements.

TABLE IV

AVERAGE FILTERABLE BETA PARTICLE EMITTERS IN AIR
OCTOBER, NOVEMBER, DECEMBER
1952

Location	Activity Density - Units of 10^{-14} $\mu c/cc$				
	Oct.	Nov.	Dec.	Quarterly Average	Maximum Weekly
200 Areas and Vicinity					
200 West Tower #4	53	370	130	180	940
200 West Redox Area	98	1300	140	500	3700
Gable Mountain	8	22	11	13	30
200 East Tower #15	22	90	81	61	130
100 Areas and Vicinity					
100-D	41	130	64	75	340
100-H	24	120	37	46	170
Hanford 101 Bldg.	5	39	20	20	110
Hanford 614 Bldg.	13	24	12	16	36
White Bluffs	8	36	22	21	80
300 Area 614 Bldg.	8	*	18	12	22
Outlying					
Richland	14	16	12	14	44
North Richland	4	13	20	12	30
Pasco	37	11	13	20	57
Kennewick	4	< 4		< 4	18
Benton City	5	10	15	9	27
Riverland	18	22	71	30	220

* Monitoring equipment out of order during this period.

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Increases in the average activity density of filterable beta particle emitters in the atmosphere during the quarter resulted from exceptionally high values detected during the month of November. Air filters which were removed after November 11 showed an exceptionally high number of radioactive particles which apparently were entering the environs from a source other than Hanford. This deposition caused an increase in activity density from values on the order of 10^{-12} μc/cc to values on the order of 10^{-11} μc/cc and, in an extreme case, a value of 3.7×10^{-11} μc/cc over a one week period. Detailed results of the particle monitoring program during this period may be referred to in the latter part of this section. If the November data were deleted, a comparison of the values summarized in Table IV with the results of similar measurements obtained in the past would show no significant difference between the two sets of data.

Air filters which were removed from dual air monitors were also used for purposes of evaluating the activity density from beta particle emitters in the atmosphere. Table V summarizes these results.

TABLE V

AVERAGE FILTERABLE BETA PARTICLE EMITTERS IN AIR

DUAL UNIT AIR MONITORS

OCTOBER, NOVEMBER, DECEMBER

1952

	Activity Density - Units of 10^{-14} μc/cc				
Location	Oct.	Nov.	Dec.	Quarterly Average	Maximum Weekly
200 West East Center # 1	21	42	125	77	172
200 West East Center # 2	31	77	114	78	155
200 East Southeast # 1	19	82	76	56	223
200 East Southeast # 2	22	54	35	36	144
Richland # 1	8	16	6	10	26
Richland # 2	20	16	18	18	44
Meteorology Tower					
Ground Level	21			21	34
200' Level	14	*	*	14	25
400' Level	17	*	*	17	23

* Discontinued during construction of elevator on Meteorology Tower.

The data obtained from analyzing filters removed from dual air monitors reflected lower values during the early part of the quarter and high values during November and December. Again, twofold increases in the average activity density during the month of November were attributed to particulate contamination which apparently did not originate from the Hanford operation. The maximum values indicated in the last column were measured during the time that particulate contamination was high throughout the Pacific Northwest.

Nearly 1,000 air filters were radioautographed during the quarter for the specific purpose of determining the number of radioactive particles in the atmosphere. The air filters were changed either daily or weekly, after which they were exposed to type K X-ray film for a one week period. The number of particles was determined by counting the number of darkened spots on the developed film. The sensitivity of this measurement based on Sr^{90} and C^{14} standards is on the order of 3 d/m. Tables VI and VII summarize the results obtained from this study at on-site and off-site locations, respectively.

Particle concentrations were on the order of magnitude expected for Hanford operation at nearly all locations during the month of October. Data collected after the first week of November showed significant increases in the number of particles in the atmosphere at all monitoring stations. Coincident with this increase in number of particles, a number of the filters which were operated weekly were changed daily. Near the separation areas, particle concentrations were on the order of 2×10^{-2} particle/m^3 prior to November 10. Filters which were operated between November 10 and November 11 showed values of 0.6 and 1.6 particles/m^3 at the 200 West area. In Richland a value of 0.6 particle/m^3 was obtained. Off-site monitors operated between November 10 and November 11 showed concentrations of 0.8, 0.1, 1.7, and 0.3 particles/m^3 at Klamath Falls, Ore., Spokane, Wash., Lewiston, Idaho, and Walla Walla, Wash., respectively. The off-site data indicated that the particulate

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TABLE VI

SUMMARY OF PARTICLE DEPOSITION NEAR SEPARATION AREAS

4TH QUARTER 1952

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

Location	Total Volume of air Sampled m^3	Oct.	Nov.	Dec.	Present Quarter Averages 1952	Previous Quarter Averages 1952
200 East and Vicinity						
2704 Outside	9274	14	57	45	39	50
BY - SE	9279	36	130	52	76	120
BY - NE	9261	14	39	32	29	140
"B" Gate	8974	13	27	36	27	45
2701 Outside	9287	18	69	96	64	63
2704 Inside	9274	16	62	22	33	42
221-B	9279	3.9	20	22	16	45
2701 Inside	9262	10	56	27	30	39
200-W and Vicinity						
2701 Outside	7737	25	22	90	56	130
2722	9282	62	43	66	58	130
"T" Gate	9282	85	72	55	69	64
222-T Outside	7961	87	68	58	69	130
231	9278	260	820	70	360	110
Redox	8965	370	790	64	380	750
W Guard Tower	9283	280	480	75	260	44
2701 Inside	9286	45	37	29	36	130
272	9282	21	57	21	32	130
222-T Hall	9180	40	32	21	30	98
222-T Lab.	9278	140	35	18	59	380
222-U Lab.	8462	59	570	19	190	140
291-S Inside	21573	-	1140	78	590	>410
"U" Plant Gate	8147	70	700	63	290	
Meteorology Tower						
3'	37094	8.0	9.9	10	9.4	32
50'	17136	1.2	0.4	*	1.1	17
100'	13608	1.6	1.3	*	1.5	18
150'	11893	3.8	5.0	*	4.0	13
200'	10986	4.8	0.5	*	4.1	14
250'	10986	3.6	2.2	*	3.4	16
300'	10182	1.3	3.5	*	1.7	20
350'	10182	4.4	0.6	*	3.7	26
400'	6853	2.6	5.3	*	3.1	33

* Filters from these locations were not processed during this period.

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TABLE VII

SUMMARY OF PARTICLE DEPOSITION OUTSIDE SEPARATION AREAS

4TH QUARTER 1952

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

Location	Total Volume of air Sampled m^3	Oct.	Nov.	Dec.	Present Quarter Averages 1952	Previous Quarter Averages 1952
Area Locations						
100-B Area	34238	2.0	13	12	10	7.6
100-D Area	37128	1.3	5.8	36	16	6.9
White Bluffs	29053	1.9	5.8	6.3	4.9	8.9
100-F Area	31688	2.4	4.1	34	17	17
300 Area	37111	17	49	40	36	30
Hanford 101	37009	1.4	2.6	15	6.9	9.4
Off Area Locations						
Benton City, Wash.	37179	0.6	4.8	28	12	4.7
Pasco, Wash.	36652	0.8	0.7	23	9.4	5.2
Richland, Wash.	37094	2.7	8.7	46	21	9.3
Boise, Idaho	23072	6.6	1.9	190	44	54
Klamath Falls, Ore.	9068	<0.3	1.5	63	25	21
Great Falls, Mont.	8642	3.1	1.9	130	57	82
Walla Walla, Wash.	9497	1.4	1.1	45	19	33
Meacham, Ore.	9986	0.8	1.0	49	18	15
Lewiston, Idaho	8484	0.4	<0.4	140	54	30
Spokane, Wash.	37128	0.1	0.2	23	9.0	16
Kennewick, Wash.	15398	*	1.4	11	8.4	12
Yakima, Wash.	17663	0.3	<0.2	*	0.2	5.6

* Filters from these locations were not processed during this period.

contamination was wide-spread over the Pacific Northwest and the predominance of higher values at the remote locations indicated that the source of these particles was probably not connected with the Hanford operation. Another increase was noted on filters which were operated between November 19 and November 20; the number of radioactive particles during this period was on the order of 0.2 particle/m^3 at nearly all stations. A detailed study of particle deposition during this period is being presented in a separate document.

[redacted]

The number of radioactive particles in the Hanford environs would be on the order of magnitude expected for Hanford operations if the above described data were deleted. Particle concentrations approached expected values at nearly all locations during the latter part of December.

The activity density from I^{131} in the atmosphere was measured by analyzing caustic scrubber solutions through which air flows of 2 to 2.5 cfm were passed for periods ranging from one to seven days. Table VIII summarizes the results obtained from this measurement.

TABLE VIII

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

OCTOBER, NOVEMBER, DECEMBER

1952

Units of 10^{-12} µc/cc

Location	Oct.	Nov.	Dec.	Quarterly Average	Maximum Weekly
200 Area and Vicinity					
200 East Southeast	0.4	<0.1	0.2	<0.2	1.0
200 East Tower # 16	0.5	0.4	0.5	0.5	2.8
200 West Gatehouse	<0.1	<0.1	0.6	<0.2	0.8
Gable Mountain	<0.1	<0.1	<0.1	<0.1	0.2
Redox Area	0.6	0.4	0.5	0.5	0.9
200 West Tower #4	0.2	<0.1	0.2	<0.2	0.8
Outlying Areas					
100-H Area	<0.1	<0.1	<0.1	<0.1	<0.1
300 Area	<0.1	<0.1	<0.1	<0.1	0.1
Richland	0.1	<0.1	<0.1	<0.1	0.2
North Richland	<0.1	<0.1	<0.1	<0.1	<0.1
Benton City	<0.1	<0.1	<0.1	<0.1	0.2
Pasco	<0.1	<0.1	<0.1	<0.1	<0.1
Kennewick	<0.1	<0.1	<0.1	<0.1	<0.1

The amount of I^{131} in the atmosphere decreased to trace quantities during the quarter. This decrease paralleled a near-significant reduction in the amount of I^{131} discharged to the atmosphere from the separation areas. Airborne I^{131} concentrations during this period were the lowest observed since the inception of the scrubber monitoring program several years ago.

Sixty-three I^{131} samples were collected during periods when low dilution of stack effluent existed. Sixteen of these samples showed values in excess of 1×10^{-9} μc/cc and two samples showed values above 5×10^{-9} μc/cc. The maximum measurement showed the activity density from I^{131} to be 2.3×10^{-8} μc/cc; this sample was collected 2,000 feet south of the T-Plant stack when dilutions were 300:1. Wind velocity during the sampling period was less than three miles per hour.

The activity density from alpha particle emitters in the environs was determined by analyzing air filter samples. Table IX summarizes these results.

TABLE IX

GROSS ALPHA PARTICLE EMITTERS IN AIR

OCTOBER, NOVEMBER, DECEMBER

1952

Location	Number Samples	Activity Density - Units of 10^{-15} μc/cc	
		Maximum	Average
200 West Tower # 4	13	89	33
Gable Mountain	10	18	5
Richland	26	24	8
Kennewick	5	57	< 4
Pasco	13	130	24
300 Area	9	21	12
100-D Area	13	37	23
Benton City	13	4	< 4
Hanford 614 Building	12	11	< 4
White Bluffs	13	10	4
North Richland North	13	19	4
200 West Redox Area	12	16	10
100-H Area	9	62	25
Hanford 101 Building	13	7	< 4
Riverland	13	10	< 4
200 East Tower # 15	13	11	8

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TABLE IX (contd.)

Location	Number Samples	Activity Density - Units of 10^{-15} μc/cc Maximum	Average
Meteorology Tower Ground Level*	4	22	16
Meteorology Tower 200' Level*	4	5	< 4
Meteorology Tower 400' Level*	4	5	< 4
PSN 320	13	30	7
Dual Monitoring Units			
200 West East Center #1	8	20	11
200 West East Center #2	11	34	14
200 East Southeast #1	12	26	6
200 East Southeast #2	13	19	5
Richland #1	13	12	4
Richland #2	13	24	11

* Discontinued during November and December

The above data are in reasonable agreement with measurements obtained during the past. A large number of the individual samples showed values less than 4×10^{-15} μc/cc; locations which showed a positive average were usually weighted by one or two high measurements on the order of 10^{-14} μc/cc. A comparison of the results obtained from dual monitoring units with those results obtained from the single monitor filters showed no significant difference.

SECTION IV

RADIOACTIVE CONTAMINATION IN HANFORD WASTES

The amount of radioactive contamination in Hanford wastes was determined by results obtained from radiochemical analysis of over 1,000 liquid and solid samples. Samples were obtained at frequencies varying from daily to weekly at the open waste sources in the Hanford manufacturing areas. These data were supplemented with portable instrument surveys over the open terrain adjacent to the waste ponds and ditches. The results of these findings are summarized for each of the operating areas.

100 AREA WASTES

Table I summarizes the results obtained from the analysis of 500 ml. samples collected at the outlet of the retention basins in the reactor areas. The tabulation includes only those samples which were analyzed within 16 hours after collection.

TABLE I
RADIOACTIVE CONTAMINATION IN REACTOR EFFLUENT WATER DURING PERIODS OF NORMAL OPERATION OCTOBER, NOVEMBER, DECEMBER 1952

Activity Density from Gross Beta Particle Emitters Units of 10^{-3} μc/cc

Location	Total Samples	October Max.	October Avg.	November Max.	November Avg.	December Max.	December Avg.
100-B Area	98	4.3	2.8	5.0	3.5	5.0	4.3
100-C Area**	15					5.9	1.9
100-D Area	116	4.0	2.7	4.6	4.1	5.0	4.1
100-DR Area	106	4.5	2.7	4.2	3.6	4.1	3.6
100-F Area	68	4.0	2.8	4.5	3.8	*	*
100-H Area	116	3.9	2.5	4.1	3.4	4.1	3.5

* Samples were not obtained from this location during December.
** This facility was placed in operation during late November.

General increases in the activity density from gross beta particle emitters throughout the quarter approached significance during the month of December. Statistical comparison of average values obtained during this period with similar measurements obtained during the previous quarter show these values to be significantly higher than those measured in the past. This increase was largely weighted by the results from samples collected during the month of December.

Radiochemical analysis of daily samples collected at the outlet of the reactor retention basins showed the average activity density from gross alpha particle emitters (plutonium and uranium) to be less than 5×10^{-9} $\mu c/cc$ at all areas. Several individual samples from each area showed positive values in the range of 1 to 2×10^{-8} $\mu c/cc$ but were not confirmed by the results of samples collected on the following day. Maximum activity densities from these alpha particle emitters were found at the 100-D and 100-DR areas where samples showed 6.7×10^{-8} $\mu c/cc$ and 5.1×10^{-8} $\mu c/cc$, respectively.

One sample per month from each of the retention basins was analyzed for polonium. Trace activity from this contaminant on the order of 10^{-9} $\mu c/cc$ was detected in nearly all samples analyzed; maximum values obtained in the 107-H samples approached 10^{-8} $\mu c/cc$.

Spot samples from each of the basins which were analyzed specifically for the activity density from either uranium or plutonium showed negligible concentrations of these contaminants.

The amount of I^{131} discharged to the Columbia River in farm wastes at the 100-F area averaged 4.1×10^{-6} $\mu c/cc$ during the quarter; the maximum measurement was 2.8×10^{-5} $\mu c/cc$. Each of these values represents increases which approached significance when these data were compared to similar measurements obtained during the previous quarter. The increase was weighted by higher values observed during the month of

December when the average was 5.4 x 10^{-6} μc I^{131}/cc. Calculations based on the metered volume of water used in the flushing operation at the Biology farm show that the average amount of I^{131} discharged to the river per day was 0.28 mc. During December 0.36 mc per day was discharged.

Portable instrument surveys were made on a monthly basis at each of the reactor area burning grounds. Readings obtained from VGM's and TGM's showed values on the order of natural background (50 to 150 c/m) in nearly all instances. Although several positive indications of contamination were found in isolated cases, the instrument readings never exceeded 1,000 c/m.

200 AREA WASTES

The results obtained from the radiochemical analysis of liquid and solid samples collected from waste sources in the separation areas are presented in Table II.

Significant increases were observed in the activity density from beta particle emitters in all samples collected from the Redox swamp. The increase in this activity was progressive throughout the quarter and was associated with a leak in the cooling system of the separation operation at the 202-S facility. The increase in activity coincided with a significant increase in the area covered by the liquid wastes. Portable instrument surveys performed on October 6 and October 9 when the volume of water in the pond was greatest, showed radiation levels ranging from 5 to 550 mrep/hr. around the pond perimeter; the latter values included from 1 to 70 mr/hr.

Portable instrument surveys using VGM meters around the perimeter of the remaining waste ponds in the 200 area showed average readings in the range of 200 to 600 c/m above background. Several readings in the B ditch inlet showed values on the order of 5,000 c/m. These data were consistent with findings during the previous quarter.

TABLE II

RADIOACTIVE CONTAMINATION IN THE 200 AREA WASTE SYSTEMS

OCTOBER, NOVEMBER, DECEMBER

1952

LIQUID SAMPLES

Location	Number Samples	Alpha Particle Emitters, Units of 10^{-8} µc/cc: Maximum	Alpha Particle Emitters, Units 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-Swamp	28	4.1	< 0.5	50	13
U-Swamp	23	13	2.7	28	4.0
Laundry Ditch	24	24	5.1	18	5.1
231 Ditch	24	9.6	1.5	8.8	2.8
200 E "B" Ditch	38	2.4	< 0.5	2.6	1.4
200 E "B" Swamp	26	5.0	0.5	19	3.7
234-35 Ditch	12	1.5	< 0.5	3.7	2.0
200 E Retention Pond	46	1.5	< 0.5	17	2.4
200 W Retention Pond	28	1.5	< 0.5	69	18
234-35 Retention Pond	8	51	20		
Redox Swamp	15	56	8.8	41000	3000

SOLID SAMPLES

Location	Number Samples	Alpha, Units of 10^{-6} µc/g: Maximum	Alpha, Units of 10^{-6} µc/g: Average	Beta, Units of 10^{-5} µc/g: Maximum	Beta, Units of 10^{-5} µc/g: Average
T-Swamp	18	440	49	200	54
Laundry Ditch	11	650	242	752	156
200 E "B" Ditch	39	35	5.0	960	61
200 E "B" Swamp	25	6.8	2.0	232	68
234-35 Ditch	12	6600	1200	20	6.9
Redox Swamp	12	850	120	920,000	110,000

300 AREA WASTES

Table III summarizes the results obtained from analyzing samples collected from 300 area waste sources for the activity density from alpha and beta particle emitters.

TABLE III
RADIOACTIVE CONTAMINATION IN 300 AREA WASTES
OCTOBER, NOVEMBER, DECEMBER
1952

Location	Number Samples	Beta Particle Emitters Units of 10^{-7} μc/cc Max.	Beta Avg.	Alpha Particle Emitters Units of 10^{-8} μc/cc Max.	Alpha Avg.	Uranium Units of 10^{-6} μc/cc Max.	Uranium Avg.
Old Pond Inlet Liquid	12	21	11	1205	482	12	4.5
New Pond Inlet Liquid	13	23	8.5	640	330	6.7	2.6
300 Area Waste Line	58	3600	120	67000	1600	870	24
		Units of 10^{-3} μc/g		Units of 10^{-6} μc/g		Units of 10^{-6} μc/g	
Old Pond Inlet Solid	13	1.6	< 1	370	95	1400	190
New Pond Inlet Solid	13	2.4	< 1	400	110	2200	530

Consistent with observations noted throughout the year, considerable fluctuation was found in the amounts of contamination at the above locations. A comparison of these data with similar measurements during the previous quarter indicates that the current average contamination levels were consistent with those noted in the past. Samples from the 300 area waste line which were analyzed specifically for plutonium showed values on the order of 10^{-9} μc/cc throughout the three month period. Several samples of mud collected at the perimeter of the waste ponds showed plutonium on the order of 10^{-6} μc/g.

SECTION V

RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER

The magnitude and extent of radioactive contamination admitted to the Columbia River in reactor cooling water was determined by analyzing several hundred samples of river water for the activity from gross beta and gross alpha particle emitters. Weekly samples were obtained from eighteen control locations between the reactors and Patterson; daily samples were collected in the region of higher contamination near the Hanford Ferry. These data were supplemented with weekly background studies in the upstream Columbia River and at the mouth of the Yakima and Snake Rivers. Several random samples from remote downstream Columbia River locations and from non-related rivers in the Pacific Northwest were also analyzed.

The results of the radiochemical analysis for the activity from gross beta particle emitters at all locations which were sampled on a scheduled basis during the quarter are presented in Table I.

General increases in the activity density from gross beta particle emitters which were observed during August and September continued during this quarter. A decrease in average flow rate of the Columbia River, from 976,000 gallons per second during July, August, and September to an average of 424,000 gallons per second during this period, largely accounted for the magnitude of the increase in activity density. Mean flow rates for October, November, and December were 442,000, 411,000, and 420,000 gallons per second, respectively. The minimum flow rate was 353,000 gallons per second measured on October 28; the maximum measured flow was 488,000 gallons per second on December 3. A graph showing the trend of the measured flow rate over the past six month period is presented in Figure 5.

TABLE I
AVERAGE ACTIVITY DENSITY OF GROSS BETA PARTICLE EMITTERS IN THE COLUMBIA RIVER
OCTOBER, NOVEMBER, DECEMBER
1952
Units of 10^{-8} μc/cc

Location	Oct. Avg.	Nov. Avg.	Dec. Avg.	Quarter Avg.	Last Quarter Avg.	Maximum Measurement This Quarter
Wills Ranch	< 5	< 5	< 5	< 5	< 5	7
100-B 181 Bldg.	< 5	38	< 5	<18	16	170
Allard Pumping Station	270	310	670	440	120	1100
100-D 181 Bldg.	140	270	560	300	92	650
100-H 181 Bldg.	500	360	580	470	170	680
Below 100-H	830	910	1200	1000	320	2800
100-F 181 Bldg.	530	900	1100	750	360	1100
Below 100-F	920	1500	810	1100	370	1800
Hanford South Bank	1000	990	680	900	460	1700
Hanford Middle	750	810	760	770	340	1100
Hanford North Bank	420	350	580	440	180	700
300 Area	400	380	330	370	200	730
Richland	470	450	470	460	160	660
Yakima River Mouth	< 5	< 5	< 5	< 5	< 5	10
Highland Pumping Station	180	320	290	280	120	400
Pasco-Kennewick Bridge						
Kennewick Side	88	170	170	140	100	290
Pasco Side	220	300	240	260	98	380
Sacajawea Park	120	150	180	150	55	280
Snake River Mouth	< 5	< 5	< 5	< 5	< 5	6
McNary Dam	72	68	77	73	39	110
Patterson	81	59	62	67	29	87
Bonneville	14	-	-	14	< 5	14

Another cause contributing to the increase in activity density from gross beta emitters measured in the river was the general increase in power levels at which the reactors were operated during this quarter.

Radiochemical analysis of one gallon samples of river water obtained from locations 185 to 235 miles downstream from the Hanford reactors during the first week of December showed trace activity density from beta particle emitters. Samples from North Bonneville, Wash., Stevenson, Wash., and The Dalles, Oregon, showed values of 2.7×10^{-8} $\mu c/cc$, 3.5×10^{-8} $\mu c/cc$ and 8.4×10^{-8} $\mu c/cc$, respectively. The detection limit for the one gallon samples uncorrected for decay is 2.8×10^{-9} $\mu c/cc$. Each measurement was confirmed by recount. The flow rate of the river was 488,000 gallons per second at the time the samples were collected.

All samples obtained from the Columbia River were analyzed for the activity from gross alpha particle emitters. In all cases, the average at a given location was $<5 \times 10^{-9}$ $\mu c/cc$. Several spot samples which were specifically analyzed for uranium and plutonium showed no activity from these contaminants.

The activity density from beta and alpha particle emitters which may occur naturally in the Columbia, Yakima, and Snake Rivers, and in several remote rivers in the Pacific Northwest, was below the detection limit of the measurement in all samples analyzed.

Twenty-six samples of Columbia River water obtained from a location near the Hanford Ferry were analyzed for I^{131}. The average activity density from this contaminant was 1.0×10^{-7} $\mu c/cc$ during the quarter; the maximum measurement was 2.1×10^{-7} $\mu c/cc$ in a sample collected during November. A comparison of the average activity density from I^{131} in the river with similar data obtained during the previous quarter shows current values to be about 30 per cent higher. Continued decreases in flow rate of the Columbia River during the period caused this increase which was a continuation of a trend noted during the latter part of the previous quarter.

Estimates of the amount of radioactive material deposited by the contaminated waters of the Columbia River were made by analyzing mud samples which were collected from representative locations along the shore of the river. Samples were collected on a weekly basis at the edge of the water and at an underwater location 5 feet from the shore. The results obtained from the radiochemical analysis for the activity from gross beta particle emitters at locations which were sampled repetitively during the quarter are presented in Table II.

TABLE II

RADIOACTIVE CONTAMINATION IN COLUMBIA RIVER MUD SAMPLES

OCTOBER, NOVEMBER, DECEMBER

1952

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

Location	Oct. Avg.	Nov. Avg.	Dec. Avg.	Quarter Avg.	Last Quarter Avg.	Maximum This Quarter
Wills Ranch						
Shore	2.5	3.2	2.6	2.7	4.2	4.8
5' Out	3.7	2.5	3.8	3.4	2.8	5.6
Allard Station						
Shore	9.8	9.0	7.8	8.9	4.6	16
5' Out	10	9.3	6.6	9.2	4.5	15
100-H Area						
Shore	15	9.2	7.1	10	6.5	43
5' Out	75	8.2	11	31	4.8	280
Below 100-F						
Shore	8.6	12	11	10	11	20
5' Out	26	20	12	19	12	54
Hanford Ferry						
Shore	12	14	9.3	12	10	19
5' Out	12	14	12	12	15	33
300 Area						
Shore	10	11	10	10	6.5	17
5' Out	7.6	9.0	8.4	8.3	6.4	12
Byers Landing						
Shore						
5' Out	6.1	5.6		5.9		6.1
Richland Dock						
Shore	8.6	8.7	5.4	7.6	7.8	16
5' Out	15	9.7	9.6	11	8.2	18

TABLE II (contd.)

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

Location	Oct. Avg.	Nov. Avg.	Dec. Avg.	Quarter Avg.	Last Quarter Avg.	Maximum This Quarter
Kennewick Highland Pump Plant						
Shore	7.4	6.0	8.8	7.3	5.8	13
5' Out	12	12	10	11	5.8	24
PK Bridge (Pasco)						
Shore	6.0	6.3	4.1	5.5	4.5	11
5' Out	11	5.6	4.2	7.0	5.6	21
PK Bridge (Kennewick)						
Shore	7.6	7.5	5.1	6.8	5.0	14
5' Out	7.3	8.1	6.2	7.3	4.9	16
Sacajawea Park						
5' Out	20	10	16	16	7.6	32
McNary Dam						
5' Out	4.0	5.4	3.9	4.4	5.8	6.3
Patterson						
5' Out	4.4	3.2	3.4	3.6	4.6	7.2
Snake River Mouth						
5' Out	3.9	3.4	2.7	3.3	4.0	4.8

Average values indicated in Table II were comparable to those observed during the previous quarter. Slightly higher values observed near the 100-F and 100-H areas and at the Hanford Ferry were consistent with previous data and were expected, as these locations are in the region where highest contamination was found in the Columbia River. The one sample at the 100-H area which showed 2.8×10^{-3} μc/g during October was not confirmed by subsequent samples.

Nearly two hundred samples were collected from the raw water river export line at the 183 and 283 buildings in the operating areas. This water originates from the Columbia River and is ultimately used for consumption purposes in the areas. These measurements represent the water prior to chlorination and final filtration. Table III summarizes the results obtained from analyzing these samples for the activity from gross beta particle emitters.

TABLE III

RADIOACTIVE CONTAMINATION IN RAW WATER

RIVER EXPORT LINE

OCTOBER, NOVEMBER, DECEMBER

1952

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

Location	Oct. Avg.	Nov. Avg.	Dec. Avg.	Quarter Avg.	Last Quarter Avg.	Maximum This Quarter
183 Bldg., 100-B Area	< 5	< 5	< 5	< 5	< 5	9
183 Bldg., 100-D Area	34	40	69	45	10	10
183 Bldg., 100-DR Area	52	43	76	54	11	110
183 Bldg., 100-H Area	120	86	95	99	20	230
183 Bldg., 100-F Area	130	110	51	100	39	140
283 Bldg., 200-E Area	< 5	19	28	<17	< 5	43
283 Bldg., 200-W Area	13	28	61	35	< 5	110

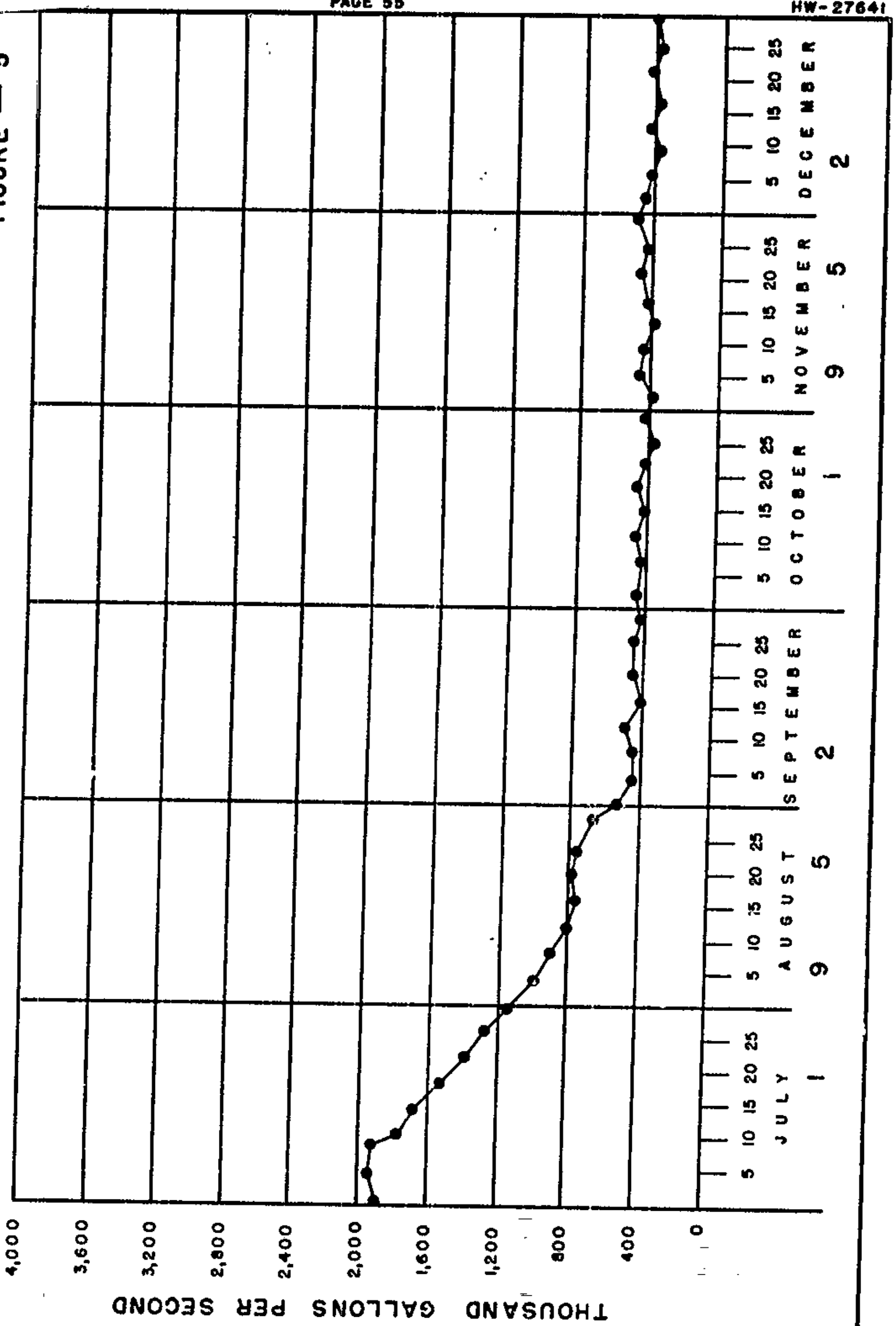
Significant increases in activity by factors ranging from 3 to 5 at several of the operating areas were expected as the amount of radioactive contamination in these water sources increases when the flow rate of the Columbia River decreases. The average values summarized in Table III are on the same order of magnitude as those observed during the same period in 1951 when the range of these measurements was from 2.6×10^{-7} μc/cc to 9.5×10^{-7} μc/cc.

FIGURE — 5

COLUMBIA RIVER FLOW

OCTOBER – NOVEMBER – DECEMBER

1952



SECTION VI

RADIOACTIVE CONTAMINATION IN RAIN

The amount of radioactive contamination brought to the earth in rainfall was determined by analyzing 133 samples of rainfall which were collected at representative locations in the environs. The bulk of these samples were collected during the month of December when nearly 80 per cent of the rain measured during the quarter occurred. Table I summarizes the rainfall data as measured at the Meteorology station near the 200 West Area; similar data for the past three years are included for comparison.

TABLE I

PRECIPITATION MEASURED AT HANFORD WORKS

OCTOBER, NOVEMBER, DECEMBER

1952

Units - inches

Year	October	November	December	Quarterly Total
1949	0.10	1.47	0.16	1.73
1950	2.46	0.55	0.97	3.98
1951	0.71	0.82	0.70	2.23
1952	0.04	0.20	0.77	1.01

The results obtained from analyzing rainfall samples for the activity density from gross beta particle emitters are summarized in Table II.

TABLE II

ACTIVITY DENSITY FROM GROSS BETA PARTICLE EMITTERS IN RAIN

OCTOBER, NOVEMBER, DECEMBER

1952

Location	No. Samples	Units of 10^{-6} μc/cc Maximum	Units of 10^{-6} μc/cc Average
In 200 East Area	19	97	16
250' E of stack	5	52	13
2000' E of stack	5	60	14
750' SE of stack	4	54	16
3500' SE of stack	5	97	21
In 200 West Area	29	160	26
1000' E of stack	6	140	27
7000' E of stack	5	110	24
8000' SE of stack	6	160	30
4900' SE of stack	6	130	24
Redox Area	6	73	27
100 Area Environs	31	19	4
100-B SE	4	6	2
100-D SW	5	19	6
100-F SW	4	4	2
Hanford 614	5	8	4
Hanford 101	4	19	7
White Bluffs	4	10	4
100-H SE	5	15	5
Perimeter Locations	22	30	5
Richland	5	19	5
Pasco H and R	5	30	6
Benton City	3	9	3
Riverland	5	28	7
North Richland	4	8	3
Intermediate Locations	32	84	7
Route 4S, Mile 6	5	15	5
300 Area 614	3	8	3
200 North 614	5	84	18
Gable Mountain	1	2	2
Batch Plant	9	27	4
622 Building	9	37	6

The activity density from beta particle emitters in rainfall increased at all locations during this quarter. Average increases, ranging from factors of 5 to 20 when compared with data collected during the previous quarter, were largely weighted by exceptionally high measurements obtained during late November and early December.

The periods during which the high values occurred were identical to those in which the results obtained from the air monitoring program (Section III) showed exceptionally high radioactive particle concentrations in the environs. Several of the rain samples which were radioautographed showed the presence of radioactive particles; the intensity of these particles was in the range of 3 d/m to 10 d/m when compared with Sr^{90} standards.

Deletion of those measurements which were associated with particulate contamination would result in lowering the average values listed in Table II to the order of magnitude observed during the previous quarter. During October, the maximum activity density from beta particle emitters in rainfall was 3.5×10^{-6} μc/cc; this value was identical to the maximum average value which was observed near the Redox facility during the previous quarter.

SECTION VII

RADIOACTIVE CONTAMINATION IN DRINKING WATER SUPPLIES AND TEST WELLS

The activity density from gross beta and gross alpha particle emitters in drinking water and well supplies was determined by results obtained from the radiochemical analysis of nearly 1,000 samples. Approximately 650 of these were 500 ml samples which were used for determining the activity density from gross alpha and beta particle emitters. The remaining samples were 11.7 liter samples which were used when increased sensitivity was necessary. The larger volume samples were also used for specific analysis for uranium and plutonium.

The frequency of sampling a given location varied from daily to monthly; most of the drinking water supplies were sampled at weekly intervals and most test wells were sampled on a monthly basis.

Table I summarizes the results obtained at locations where the average activity density from alpha particle emitters exceeded the individual sample detection limit of 5×10^{-9} μc/cc during the quarter.

Consistent with previous observations, trace alpha particle emission was found in Benton City drinking water supplies and in several of the Richland wells. Trace quantities of uranium, which presumably occurs naturally in the water table below the Richland-Benton City region, were detected in each of the samples which showed positive alpha particle emission. Locations outside the Richland-Benton City region which showed a positive average during the quarter were largely weighted by one high result from a single sample; the higher values were not confirmed on the same order of magnitude by resamples. The outlying wells did not show significant quantities of uranium. In addition to the locations shown in Table I, many of the individual samples collected from other drinking water supplies in the environs show trace alpha particle emission

TABLE I
CONTAMINATION FROM ALPHA PARTICLE EMITTERS IN DRINKING WATER
OCTOBER, NOVEMBER, DECEMBER
1952

500 ml Samples

Location	Number Samples	Alpha Particle Emitters Units of 10^{-9} μc/cc Max.	Avg.	Number Samples	Uranium Units of 10^{-3} μg/cc Max.	Avg.
Richland Well #4	60	42	6	60	10	4
Richland Well #5	12	44	7	12	5	2
Richland Well #12	11	12	8	12	17	6
Richland Well #14	12	9	5	12	5	4
Richland Well #15	12	8	5	12	13	.5
White Bluffs Fire Hall	11	58	10	12	4	<2
Benton City Store	13	28	12	2	6	5
Benton City Water Co.	4	21	15	11	18	13
100-C Sanitary	3	13	6	3	<2	<2
100-K Area #1	10	25	6	11	2	<2

at some time during the three month period. In most instances, the activity density was on the order of 10^{-9} μc/cc and specific measurements for uranium and plutonium did not indicate the presence of either of these contaminants. A complete tabulation showing the results obtained from all drinking water supplies sampled during the three month period is presented in Table II.

Drinking water supplies in which the activity density from alpha particle emitters was of questionable significance were resampled using a large volume sample (11.7 liters). This increased the sensitivity of the individual measurement from 5×10^{-9} μc/cc to 2×10^{-10} μc/cc. The results obtained from analyzing the large volume samples are summarized in Table III.

TABLE II

SUMMARY OF ALPHA AND BETA PARTICLE EMITTERS MEASURED IN DRINKING WATER

OCTOBER, NOVEMBER, DECEMBER 1952

500 ml Samples

Location	Number 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 #4	62	42	6	8	< 1
Richland Well #5	12	44	7	3	< 1
Richland Well #12	12	12	8	3	1
Richland Well #13	11	7	4	4	< 1
Richland Well #14	12	9	5	3	< 1
Richland Well #15	12	8	5	10	2
Richland Well #18	12	11	5	4	< 1
Tract House J-685	11	9	3	1	< 1
3000 Area Well "A"	12	14	3	2	< 1
3000 Area Well "B"	11	12	3	2	< 1
3000 Area Well "C"	12	6	3	3	1
3000 Area Well "D"	2	5	4	1	< 1
3000 Area Well "E"	11	5	2	1	< 1
Durand Well #5	11	5	2	2	< 1
Columbia Field Well "A"	12	4	2	4	1
Columbia Field Well "B"	11	4	2	2	< 1
Columbia Field Well "C"	10	17	4	4	1
Hanford Well #1	11	5	2	1	< 1
Hanford Well #4	11	5	2	3	< 1
Hanford Well #7	12	40	4	3	1
Headgate Well	11	2	< 2	2	< 1
1100 Area Well #8	12	4	3	14	2
Midway	12	4	< 2	1	< 1
Riverland	12	8	2	5	< 1
Lower Knob	11	2	< 2	4	1
Wills Ranch	10	3	< 2	2	< 1
Pistol Range	13	6	3	2	< 1
White Bluffs Fire Hall	11	58	10	21	6
White Bluffs Telephone Exchange	8	5	2	26	6
Pasco Improvement Farm Well	3	4	3	37	13

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TABLE II (contd.)

500 ml Samples

Location	Number Samples	Alpha Particle Emitters, Units of 10^{-9} $\mu c/cc$: Max.	Alpha Particle Emitters, Units of 10^{-9} $\mu c/cc$: Avg.	Beta Particle Emitters, Units of 10^{-8} $\mu c/cc$: Max.	Beta Particle Emitters, Units of 10^{-8} $\mu c/cc$: Avg.
Benton City Store	13	28	12	1	< 1
Benton City Water Co. Well	4	20	15	1	< 1
Kiona (Cobb's Corner)	13	5	3	3	< 1
Enterprise Well	13	6	2	4	1
Kennewick Standard Station	13	2	< 2	40	22
100-B (Sanitary)	12	2	< 2	4	1
100-C (Sanitary)	3	13	6	1	< 1
100-D (Sanitary)	13	2	< 2	44	23
100-DR (Sanitary)	12	3	< 2	32	15
100-H (Sanitary)	14	3	3	120	48
100-F (Sanitary)	13	3	< 2	63	30
100-K Area Well #1 Sanitary	11	94	20	29	6
200 East Sanitary	13	4	< 2	17	7
200 West Sanitary	12	2	< 2	51	21
300 Area	13	7	3	2	< 1
251 Building	12	12	< 2	2	1
Byers Landing	2	10	5	47	23
Redox Administration Bldg.	13	3	< 2	47	13
Sacajawea Park	10	8	5	2	< 1
McNary Dam	13	9	< 2	8	3
Patterson	13	8	3	5	< 1
Plymouth	12	3	3	< 1	< 1
Prosser	13	2	< 2	2	< 1
Pasco Sanitary	13			170	120

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TABLE III

ACTIVITY DENSITY FROM ALPHA PARTICLE EMITTERS IN DRINKING WATER

OCTOBER, NOVEMBER, DECEMBER 1952

11.7 liter samples

Location	Number Samples	Units of 10^{-10} μc/cc	
		Maximum	Average
Richland Well #4	6	27	12
Richland Well #5	4	19	7
Richland Well #12	4	26	16
Richland Well #13	5	27	14
Richland Well #14	4	19	10
Richland Well #15	5	48	32
Richland Well #18	6	33	18
Tract House J-685	4	8	6
Columbia Field Well "A"	4	7	4
Columbia Field Well "B"	3	7	6
Columbia Field Well "C"	3	16	8
1100 Area Well #8	4	18	10
3000 Area Well "A"	3	20	11
3000 Area Well "B"	3	10	6
3000 Area Well "C"	3	12	7
3000 Area Well "D"	1	18	18
3000 Area Well "E"	2	12	9
3000 Area Durand #5	4	19	12
Benton City Store	4	65	35
Benton City Water Co.	4	48	28
Kiona (Cobb's Corner)	4	14	8
Enterprise Well	4	5	4
Headgate Well	6	12	7
Kennewick Standard Station	3	9	7
Riverland	6	5	4
Midway	3	6	4
Lower Knob	3	7	5
Wills Ranch	3	3	2
Hanford Well #1	3	4	3
Hanford Well #4	3	23	16
White Bluffs Fire House	4	17	11
Pistol Range	4	15	10
Hanford #7 Sanitary	4	6	5
251 Building Sanitary	5	6	3
3000 Pond Inlet (Raw)	1	14	14
Bonneville Dam	1	4	4

The average and maximum measurements summarized in Table III were on the order of magnitude expected and were in good agreement with similar measurements observed during the earlier part of 1952.

The activity density from gross beta particle emitters in drinking water supplies was determined by the analysis of all 500 ml samples which were obtained from locations indicated in Table II. A complete tabulation of these results for all drinking water supplies monitored during the quarter may be referred to in Table II. All water supplies which showed average concentrations of beta particle emitters above the detection limits for an individual analysis (5×10^{-8} μc/cc) were using the Columbia River as a source of supply. General increase in these concentrations by a factor of 3 at downstream locations and by factors ranging from 2 to 8 at the reactor areas were on the order expected from increased concentrations in the river due to the low flow rates observed.

Several drinking water sources which do not use the Columbia River water showed trace quantities of beta particle emitters in isolated samples. However, resamples of these same sources, which were obtained within one week of the original measurement, did not confirm the original positive indications in any event.

Approximately twenty drinking water samples were obtained from sanitary water sources at various remote communities in the states of Washington and Oregon. The average activity density from gross beta and gross alpha particle emitters in any individual sample did not exceed the sensitivity limits of 5×10^{-8} μc/cc and 5×10^{-9} μc/cc, respectively.

Table IV summarizes the results obtained from the radiochemical analysis of samples of filtering media and waters which were collected at the filter plant in Pasco, Washington.

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TABLE IV
PASCO FILTER PLANT MEASUREMENTS
OCTOBER, NOVEMBER, DECEMBER
1952

Type Sample	No. Samples	Activity Density Gross Beta Particle Emitters: Maximum	Average
Water Entering Plant from River	13	3.8×10^{-6} µc/cc	2.6×10^{-6} µc/cc
Sand (surface of sand filter)	11	7.5×10^{-4} µc/g	2.3×10^{-4} µc/g
First Backwash Material (liquid)	10	1.8×10^{-6} µc/cc	1.2×10^{-6} µc/cc
First Backwash Material (solid)	11	5.2×10^{-2} µc/g	2.9×10^{-3} µc/g
Coal (surface of coal filter)	10	3.9×10^{-4} µc/g	2.3×10^{-4} µc/g
First Backwash Material (liquid)	9	1.8×10^{-6} µc/cc	1.3×10^{-6} µc/cc
First Backwash Material (solid)	10	4.6×10^{-2} µc/g	2.4×10^{-2} µc/g
Water Leaving Plant	13	1.7×10^{-6} µc/cc	1.2×10^{-6} µc/cc
Foam from sand filter	6	1.6×10^{-2} µc/g	1.1×10^{-2} µc/g
Foam from coal filter	5	7.8×10^{-3} µc/g	6.5×10^{-3} µc/g

Threefold increases in the activity density of beta particle emitters in the river water entering the plant for processing caused general increases in the activity from beta particle emitters in samples of the sand filter and coal filter materials. Corresponding increases were also noted in the water leaving the plant for consumption. Again, these increases represent a seasonal fluctuation which is observed annually when the low flow rates of the Columbia River prevail.

Nearly two hundred 500 ml samples of water collected from test wells drilled at the request of Geology were analyzed during the three month period. The results obtained at locations where the average activity density from alpha particle emitters exceeded the individual detection limit of 5×10^{-9} µc/cc are presented in Table V.

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TABLE V
ACTIVITY DENSITY FROM ALPHA PARTICLE EMITTERS
IN TEST WELLS
OCTOBER, NOVEMBER, DECEMBER
1952

Location	Alpha Particle Emitters No. Samples	Units of 10^{-9} μc/cc Max.	Avg.	Uranium No. Samples	μg U/cc Max.	Avg.
300 Area Well #1	11	73	12	11	70	9
300 Area Well #3	21	62	35	22	4000	230
300 Area Well #4	13	160	100	11	150	85
300 Area North Well	5	2300	1800	6	3200	1900
B-Y Well	12	21	5	-	-	-

Expected decreases were observed in the activity density from alpha particle emitters in each of the 300 area wells. These decreases are noted each fall when the Columbia River recedes and ceases to push the underground contamination below the 300 area waste lines into the 300 area wells. As in the past, significant quantities of uranium were detected in all 300 area well samples.

In addition to test wells which showed positive activity, all remaining test wells in the environs were sampled during the quarter. Trace quantities of beta particle emitters were found in only eight test wells. Six of these wells which were randomly located showed values barely exceeding the detection limit of 5×10^{-8} μc/cc; maximum beta measurements were found in the 300 area wells where well Number 3 showed this activity on the order of 5×10^{-7} μc/cc.

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