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DEVELOPMENT DIVISION

HEALTH INSTRUMENT DIVISIONS

**RADIOACTIVE CONTAMINATION IN
THE ENVIRONS OF
THE HANFORD WORKS
FOR THE PERIOD
JANUARY, FEBRUARY, MARCH, 1949**

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GENERAL ELECTRIC

NUCLEONICS DEPARTMENT

HANFORD WORKS

RICHLAND, WASH.

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RADIOACTIVE CONTAMINATION IN THE ENVIRONS
OF THE HANFORD WORKS

FOR THE PERIOD

HW--14243

JANUARY, FEBRUARY, MARCH, 1949.

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W. Singlevich and H. J. Paas

December 23, 1949

DEVELOPMENT DIVISION

HEALTH AND SAFETY DIVISIONS

GENERAL ELECTRIC COMPANY

HANFORD WORKS

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RADIOACTIVE CONTAMINATION IN THE ENVIRONS OF THE HANFORD WORKS
FOR THE PERIOD JANUARY, FEBRUARY, MARCH, 1949

INTRODUCTION:

This report summarizes in somewhat more detail than the monthly H.I. Environs Reports the extent and magnitude of the radioactive contamination detected in the environs of the Hanford Works. Radioactive contamination resulting from the operation of the Hanford Works as well as that found occurring in natural quantities is included. This belated report is being issued merely for the records to serve as a composite summary of measurements already reported in the monthly H.I. Environs reports and covers the quarterly period January, February, and March, 1949.

ABSTRACT:

SECTION I- METEOROLOGICAL DATA:

Wind directions in the northwest quadrant prevailed throughout this period as measured within the separations area. The wind directions at the 100 Areas differed significantly from those observed in the 200 Areas. The trend of the deposition of radioactive effluent from the separations area stacks on the vegetation followed the general pattern of the observed wind directions. Charts and graphs summarizing meteorological conditions during actual dissolving hours are attached.

SECTION II- AIRBORNE CONTAMINATION AND AIR RADIATION LEVELS:

Dosage rates measured by C type ionization chambers fluctuated around the normal instrument background of 0.3 to 0.5 mrep/24 hours during this period. M and S type ionization chambers indicated approximately 1.0 mrep/24 hours dose rate near and south east of the separations area. In general, all ionization chambers indicated levels of radiation comparable with those levels measured during the previous three month period. Filterable beta activity at a station in the 200 East Area was as high as 1.9×10^{-9} $\mu\text{c/liter}$ of air sampled although the overall average activity detected in the filters at most locations was of the same order of magnitude as that measured in the previous quarter. Detailed data are included in attached graphs and tables. Beta activity from I-131 in the atmosphere as detected by analyzing a scrubber solution through which the air was passed varied between 10^{-9} and 10^{-10} $\mu\text{c/liter}$ inside the 200 West Area.

SECTION III- ALPHA AND BETA CONTAMINATION IN THE COLUMBIA RIVER:

The average beta-gamma activity measured in the Columbia River water samples during this period varied from < 50 $\mu\text{c/liter}$ above the 100-B Area to a maximum of 1943 $\mu\text{c/liter}$ near the south bank of the river near Hanford and dropping to about 194 $\mu\text{c/liter}$ near Pasco. The average river flow was about 350,000 gallons per second. These activity levels are higher than those measured in the previous quarter and are directly a function of the decreased river flow normally experienced at this time of the year. A cross-section survey of the Columbia indicated that the distribution of the radioactive contamination in the river was not uniform from the 100-B Area to some point just below Hanford; the distribution approached uniformity in the river between 300 Area and Pasco. There is evidence to indicate that the distribution of the activity in the river varied somewhat with the different flow rates of the Columbia normally experienced throughout any year. Decay and absorption studies indicated that 90-95 per cent of the activity in the river was from 14.8 hour sodium (Na^{24}) with 2-5 per cent of the activity contributed by such isotopes as Fe^{59} , P^{32} , Co^{45} , and Cr^{51} . Detailed tables and graphs summarizing all measurements are included.

SECTION IV- ALPHA AND BETA-GAMMA CONTAMINATION IN DRINKING WATER AND TEST WELLS

No outstanding changes or trends were noted in comparing the current levels of radioactive contamination in drinking water samples with those of the previous

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quarter. The usual 2-10 $\mu\text{g U/liter}$ water presumably occurring as natural uranium was detected in Richland drinking water with slightly higher values for Benton City water. Beta-gamma activity of 50-60 $\mu\text{mc/liter}$, principally from Na^{24} , was measured in drinking water from the Kennewick-Pasco area. This area uses the Columbia River as its source of supply for drinking water. Beta-gamma activity in raw river water varied from $<10 \mu\text{mc/liter}$ to 120 $\mu\text{mc/liter}$ with positive activity detected in the 100-F Area sanitary water only; the average level was 23 $\mu\text{mc/liter}$. Alpha activity from plutonium and for uranium in the water supplied by the Columbia River was less than 6 dis/min/liter. Graphs and tables summarizing all data in detail are included.

SECTION V - BETA CONTAMINATION IN RAIN:

Beta-gamma activity measured in rain samples collected inside the separations area varied between 1-20 $\mu\text{mc/liter}$. The maximum activity in any rain sample was 60 $\mu\text{mc/liter}$ collected near the base of the 200 West Area stack. The average activity in rain samples collected outside the perimeter fence of the Hanford Works was less than 1 $\mu\text{mc/liter}$ although the highest individual samples in this group was 1.4 $\mu\text{mc/liter}$ collected in Richland.

SECTION VI - BETA CONTAMINATION ON VEGETATION:

The deposition on vegetation of 8 day iodine and non-volatile fission product elements emanating from the stacks in the separations area is reviewed. Tables and graphs summarizing detailed measurements are included. The maximum activity from I^{131} detected in any vegetation sample was 383 $\mu\text{mc/kg}$. This sample was taken about one mile from the 200 West Area stack in line with the prevailing northwest wind. This point of maximum ground concentration repeats itself rather consistently. 5-10 $\mu\text{mc I}^{131}/\text{kg}$ was detected in a zone about five miles from the stacks dropping to background levels in the vicinity of 3000 Area, Richland, and Pasco. The average activity on the Wahluke Slope was less than 2 $\mu\text{mc I}^{131}/\text{kg}$ vegetation with some individual samples measuring 5-6 $\mu\text{mc/kg}$ indicating a trace and spotty deposition of Hanford radioactive gas in that area. Some statistical analyses of minute quantities of deposited radioactive contamination detected on vegetation collected from off area locations point to possible trends of slightly higher deposition of I^{131} in Pasco than in Kennewick or Dayton, Washington; in general, however, these average activity levels are below the sensitivity limit for any single individual analysis.

SECTION VII - ALPHA AND BETA CONTAMINATION IN HANFORD WASTES:

Average beta-gamma activity in the 107 basins of the 100-B, 100-D, and 100-F Areas was 0.30, 0.31, and 0.37 $\mu\text{c/liter}$, respectively. The average alpha activity in the above samples was less than 30 dis/min/liter. Data from other 100 Area wastes, the 200 and 300 waste systems are also discussed in detail.

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SECTION IMETEOROLOGICAL DATA

A summary of the meteorological data for the hours of metal dissolution is presented in Figures 1 through 4. The meteorological measurements were made at the Meteorology Tower (622 building - 200 West Area) by the Meteorology Group of the Health Instrument Divisions. The period January through March, 1949, is considered in this discussion of meteorological data.

The meteorological observations covered a total period of 1248 hours; this total time element represents the total number of hours in this period when stack effluent was discharged into the atmosphere. A breakdown of this time period indicates that the observations were not biased for any one period as dissolving of irradiated uranium took place for about the same total hours in each month. For example, during January, metal was in process of dissolution for 454 hours, 384 hours in February, and 410 hours in March.

During this period, the prevailing wind direction was from the north-west thirty-nine percent of the time. The north-west quadrant accounted for more than fifty percent of the wind. This observation is relatively consistent with previous data. As usually observed in the past, the wind from the north-east quadrant was negligible. Figure 1 is a wind rose showing the percent of time that the wind was observed using an eight point compass; the data presented are the overall three month average condition.

A further breakdown of the wind direction data on a month to month basis is presented on Figure 2. It is interesting to note that some fluctuation is observed in a month to month comparison. The amount of wind observed from the prevailing northwest quadrant and from the northeast quadrant which is at a minimum, showed the least month to month variation whereas month to month variations within a

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factor of two occurred in comparing the remaining directions. The consistency of this data is of extreme interest as the trend of deposition of the separations area stack effluent on vegetation tends to follow the pattern of the wind direction reasonably well. (1) (2) (3)

Figure 3 summarizes the average wind directions observed at the 100 Areas; the wind directions at 100-B, 100-D, and 100-F are compared with the corresponding wind direction measured at the Meteorology Tower, 200-West Area. Again, this data includes only that portion of the time when irradiated metal was in the process of dissolution. During the period, the prevalence of wind from the West direction was considerably minimized when compared with the 200 West Area Meteorology Station observations. Previous quarterly summations have indicated that this difference in wind directions at the different stations within the Hanford Project proper (4) is a common occurrence. At times, trace quantities of 200 Area stack effluent activity on vegetation is detected in the area east and north of the separation areas; this deposition of radioactive contamination apparently results from the cross-over wind conditions which exist between the 100 and 200 areas.

The month to month variation in the wind direction noted at the 200 West Area as portrayed in Figure 2 is not nearly as great as the variation noted in the 100 Area Stations. A quick study of Figure 3 summarizing the 100 Area wind directions shows clearly the observed variations. The most outstanding difference was noted at 100-D Area, where during the month of March about thirty-eight percent of the wind came from the east, north-west, and north directions; the northeast direction accounted for twelve percent of the wind whereas during the months of January and February only one percent of the wind was observed from the northeast.

The atmospheric dilution ratios which existed during the quarter are graphically portrayed on Figure 4. The aloft condition (dilution factor greater than

2000:1) existed over fifty percent of the dissolving hours; this figure is about the same as noted in previous quarters. The more undesirable dilution ratio of less than 500:1 existed only eleven percent of the time; this is somewhat greater than usually observed. The increase in the observed lower dilution ratio is a direct effect of the increased amount of metal dissolution during daylight hours when the dilution factor is at its lowest ebb in the 24 hour day cycle.

The atmospheric conditions discussed in this report represent only those hours when irradiated uranium was actually being dissolved. Meteorological summations are available for the complete twenty-four hour periods. The monthly summaries issued by the Meteorological Group of the Health Instrument Divisions can be consulted for this data. (5) (6) (7)

SECTION I

(See Figures 1, 2, 3, and 4)

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SUMMARY WIND DIRECTIONS—200-W
DISSOLVING HOURS ONLY
JANUARY—FEBRUARY—MARCH
1949

FIGURE 1

SUMMARY AIR CONDITIONS—200-W
JANUARY—FEBRUARY—MARCH
1949
WIND DIRECTIONS
DISSOLVING HOURS ONLY

FIGURE 2

COMPARISON OF WIND DIRECTIONS
DISSOLVING HOURS ONLY
JANUARY—FEBRUARY—MARCH
1949

FIGURE 3

WIND DILUTION ANALYSIS
622 BLDG. — 200-W AREA
DISSOLVING HOURS ONLY
JANUARY — FEBRUARY — MARCH
1949

FIGURE 4

PER CENT TIME OBSERVED

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SECTION II

AIRBORNE CONTAMINATION AND AIR RADIATION LEVELS

The radiation levels in the air were measured by use of detachable 'M', 'S', and 'C' type ionization chambers. The airborne contamination was measured using air filtering devices which collect the aerosol beta activity as well as the random stack discharge active particles. Several new locations have been added to the routine air monitoring program during this quarter. A location map showing the approximate location of each of the current airborne contamination and radiation level monitoring stations is included in this document as Figure 5. This map supercedes a similar identification map included in an earlier report, HW-9496. (8)

Table I is a summary of the radiation levels measured at the various locations. The average dosage rates within the areas, as measured by 'C' type chambers, indicated negligible variation when compared with measurements of previous periods. Similarly, the dosage rates throughout this quarter were relatively constant when compared with each other on a month-to-month basis. A review of the quarterly averages indicated that nearly all measured values were within the range of background fluctuation, between 0.3 mrep/24 hours and 0.5 mrep/24 hours. The dosage rates measured at the monitoring stations located at random throughout the project are also presented in Table I. These dosage rates were measured by use of the 'M' and 'S' type ionization chambers. The use of the smaller capacity 'S' type chambers predominated in those locations where construction personnel are employed. The chambers are read in pairs, at intervals ranging from one to five days, depending on the chamber capacity and the radiation level in the monitored location. A study of the current 'M' and 'S' chamber readings indicated no significant trends or changes in radiation levels within the quarter. As in

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the past, dosage rates approaching 1.0 mrep/24 hours were measured at locations approximately southeast of the separations areas; this general location is directly downwind from the prevailing wind as indicated in Section I of this report.

Table II summarizes the results of the measurement for the "aerosol" beta activity in the air by use of air filtering devices. Two new stations have been established during this quarter; one in the 3000 Area which includes the airborne beta activity measurements in the residential area of North Richland, and the second, in the 200 West Area, Tower 15, which is adjacent to the currently proposed construction areas. The average beta activity detected in air by measuring the activity on the filter paper was less than 1.0×10^{-9} $\mu\text{c/liter}$ at all locations except at the 200 East Area, Tower 16. This location is directly downwind from the 200 East Area stack as well as at the downwind quadrant of the 200 West Area stack. The average at this location (1.9×10^{-9} $\mu\text{c/liter}$) was not significantly different from the average noted for the previous quarter.

Only four of the sixteen locations indicated any significant change in the average filter activity level when compared with the average of the previous quarter. The locations where this decrease was noted are randomly located about the site at 300 Area, 3000 Area, 200 East-Southeast corner, and 200 West-Tower number 4. The spotting of these locations indicates that the decrease is not necessarily a general condition as the remaining twelve stations which are located in-between these locations indicated no trend whatever. There is no assignable cause or causes known to explain this minute decrease in airborne activity at the specific locations cited. Figure 3 is a graph of the average aerosol beta activity detected on the filter at each of the stations; an evaluation of the trends observed when the current data is compared with the previous quarter's measurements is also included in the self-explained legend on the graph.

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In an effort to better evaluate the significance of the beta activity collected on the 1-1/2 inch diameter filter papers (C.W.S. No. 6) an experimental filtering device was set up in which air was sampled with the filter mounted horizontally with respect to the ground and the other mounted vertically. The same volume of air was sampled through each filter as mounted at the 200 West Area Gatehouse. Two cubic feet per minute were drawn through each filter for a period of one week after which the filterable beta activity was measured by use of thin-window counters. The first few weeks of testing indicated possible differences, although later measurements indicated that these differences were merely fluctuations about a given average level. After nine weeks testing, the data was analyzed and it was found that no difference existed as to the amount of beta activity collected on the filter regardless of being mounted vertically or horizontally. The overall average beta activity detected on the filters mounted in a vertical position was 1.7×10^{-9} $\mu\text{c/liter}$ air while for the horizontal mount the average was 2.1×10^{-9} $\mu\text{c/liter}$. The latter two filters were mounted out in the open air and were attached to the 614 building; the beta activity measured on the filter mounted in the vented cupola of the 614 building varied from 1.8×10^{-9} to 2.4×10^{-9} $\mu\text{c/liter}$ during the same period the test filters were run. No significant difference was found in the activity level on any of the three sets of filters when the overall data was analyzed statistically.

As reported in the last H. I. quarterly report, it was found that the filter paper used (C.W.S. No. 6) in the air monitoring program did not collect the gas iodine (only 3.5 per cent). In order to monitor for the 8 day iodine, (I^{131}), caustic scrubbers have been installed behind the filter, in series with the Moto-dire pump. The scrubber solution consists of a solution of 50 per cent 0.1 normal sodium hydroxide and 50 per cent 0.1 normal sodium carbonate; sodium iodide is also added

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as the carrier. Preliminary tests using the scrubber solution indicates that the I^{131} is definitely passing through the filter and is being collected in the scrubber. The I^{131} activity in the scrubber calculated back to its concentration in the air indicates that about 10^{-9} to 10^{-10} $\mu\text{C } I^{131}$ are present in a liter of air on an overall average basis in the 200 West Area. These iodine monitor units are to be installed in at least five of the permanent monitoring locations.

In addition to the measurements made on the filter papers, 168 hour exposures of the filters to sensitive K-type X-Ray film were made.

The usual dark spots noted on the developed film which is indicative of the presence of a stack discharge or otherwise "active particle" on a filter, as noted in months prior to December 1948, were absent during this period. The only assignable cause for this apparent significant decrease in the number of detected active particles is the installation of water scrubbers on the dissolver units in the 200 areas and the installation of sand filters. Exact figures for the specific efficiency of removing particulate matter of varying particle sizes by the installation of the filter and scrubber units is not known at the present time.

(SECTION II)

(See Tables 1 and 2, Figures 5, 6, & 6-A)

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TABLE I
RADIATION LEVEL OBSERVED
WITH
DETACHABLE IONIZATION CHAMBERS
(mrep per 24 hours)*

<u>"C" CHAMBER READINGS</u>				
<u>LOCATION</u>	<u>JANUARY</u>	<u>FEBRUARY</u>	<u>MARCH</u>	<u>QUARTERLY AVERAGE</u>
100-B Area	0.3	0.3	0.3	0.3
100-F Area	0.4	0.4	0.4	0.4
100-D Area	0.4	0.4	0.4	0.4
200-E Area	0.5	0.5	0.5	0.5
200-W Area	0.4	0.7	0.4	0.5
300 Area	---	0.5	0.5	0.5

<u>"M" AND "S" CHAMBER READINGS</u>					
<u>LOCATION</u>	<u>JANUARY</u>	<u>FEBRUARY</u>	<u>MARCH</u>	<u>QUARTERLY AVERAGE</u>	<u>GROUP AVERAGE</u>
<u>100 Areas and Environs</u>					
Route 1, Mile 8	0.5	0.6	0.5	0.5	0.55
Route 2N, Mile 10	0.7	0.3	0.3	0.4	
Route 2N, Mile 5	0.4	0.5	0.4	0.5	
Route 11A, Mile 1	0.7	0.8	0.7	0.7	
Route 1 & Route 4N	0.5	0.5	0.5	0.5	
Hanford Airport	0.8	0.5	0.8	0.7	
<u>Within 5 Miles 200-East Area</u>					
Route 4S, Mile 6	0.7	---	---	0.7	0.9
Route 11A, Mile 6	1.0	0.8	---	0.9	
Route 3, Mile 1	1.0	1.1	0.8	1.0	
Meteorology Tower 200'	0.8	0.7	---	0.8	
<u>Within 10 Miles 200 East Area</u>					
Route 4S, Mile 10	0.7	0.9	1.0	0.9	0.9
Route 10, Mile 1	0.9	1.0	0.6	0.9	
Route 10, Mile 3	0.9	---	0.9	0.9	
Route 2S, Mile 4	1.8	1.1	---	0.7	
<u>Near 300 Area</u>					
Route 4S, Mile 16	---	0.8	0.9	0.9	0.9
Route 4S, Mile 22	1.0	0.9	0.6	0.8	
<u>Residential Zones</u>					
Richland	0.5	0.5	0.4	0.5	0.5
Benton City	0.5	0.5	0.4	0.5	
<u>Construction Zones</u>					
3000 Area	0.5	0.5	0.5	0.5	
White Bluffs	0.6	0.5	0.8	0.6	
234-235 Area	0.9	0.7	0.5	0.7	
Batch Plant (200)	0.4	0.4	0.5	0.5	
101 Area	0.7	0.5	0.5	0.6	

*All of the above values include the background measurement of the instruments which vary from about 0.3 to 0.5 mrep per 24 hours.

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TABLE II

SUMMARY OF RESULTS OF AIR FILTER SAMPLING PROGRAM

FILTERABLE BETA ACTIVITY

January - February - March

1949

LOCATION	AVERAGE μ c PER LITER
Pasco	8.5×10^{-11}
100-D Area	2.4×10^{-10}
300 Area	5.9×10^{-10}
200-East - Tower 16	1.2×10^{-9}
200-West - Gatehouse	5.6×10^{-10}
Benton City	1.1×10^{-10}
Hanford	2.6×10^{-10}
White Bluffs	8.9×10^{-11}
105-DR Construction Zone	1.7×10^{-10}
Gable Mountain	2.4×10^{-10}
Richland	1.1×10^{-10}
200-West, Tower 4	5.6×10^{-10}
200-East, Southeast	8.0×10^{-10}
Hanford 101 Building	1.9×10^{-10}
3000 N Area*	1.7×10^{-10}
200 West, Tower 15*	2.7×10^{-10}

*New locations added during this quarter.

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FIGURE 5

AIR FILTER CONTAMINATION
JANUARY FEBRUARY MARCH
1949
BETA ACTIVITY

10^{-10} MICROCURIES PER LITER

Δ CURRENT VARIANCE INVALIDATES TEST

↓ SIGNIFICANT DECREASE SINCE PREVIOUS QUARTER

↔ NO SIGNIFICANT CHANGE SINCE PREVIOUS QUARTER

FIGURE 6

	AIR FILTERS		
1	400 E. AREA	1	400 E. AREA
2	300 CM. CONSTRUCTION ZONE	2	300 CM. CONSTRUCTION ZONE
3	WHITE BLUFFS	3	WHITE BLUFFS
4	CABLE MOUNTAIN	4	CABLE MOUNTAIN
5	HANFORD 614 BLDG	5	HANFORD 614 BLDG
6	HANFORD 100 BLDG	6	HANFORD 100 BLDG
7	250 W. TOWER NO. 4	7	250 W. TOWER NO. 4
8	200 W. TOWER NO. 5	8	200 W. TOWER NO. 5
9	200 WEST - EAST CENTER	9	200 WEST - EAST CENTER
10	200 E. TOWER NO. 6	10	200 E. TOWER NO. 6
11	300 E. SOUTH EAST	11	300 E. SOUTH EAST
12	BENTON CITY 614 BLDG	12	BENTON CITY 614 BLDG
13	300 E. AREA	13	300 E. AREA
14	3000 AREA NORTH	14	3000 AREA NORTH
15	700 AREA	15	700 AREA
16	PASCO	16	PASCO

LEGEND

- LOCATION
▲ CRM UNIT
○ IODINE SCRUBBER

SCALE 0 1 2 MILES

HANFORD WORKS
SAMPLING LOCATIONS
CONSTANT RATE METERS
AIR FILTER UNITS
PROJECT & VICINITY
MILITARY DIVISION — SITE SURVEY
DATE 9-2-49
DRAWN BY E. M.
CHECKED BY
APPROVED BY

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SECTION IIIALPHA AND BETA CONTAMINATION IN THE COLUMBIA RIVER

The average flow rate of the Columbia River, as measured at Richland, by the Power Division during the period, January, February, and March, 1949, was about 350,000 gallons per second. This flow rate was nearly identical to the measured flow rate during the same season in 1947; it was about 100,000 gallons per second below the measured flow rate during the first quarter of 1948. Figure 7 summarizes the trend of the Columbia River flow rate, including the period from September 1948 through March 1949. The minimum flow rates prevailed during the month of January and showed a gradual increase toward the end of the quarter. The maximum river flow during this period was 430,000 gallons per second; this maximum was lower by a factor of about two when compared with the maximum flow during the previous period. Table III is a summary of the overall average activity detected in samples from representative locations:

TABLE IIIAVERAGE BETA-GAMMA CONTAMINATION IN COLUMBIA AND YAKIMA RIVERS

<u>January</u>	<u>February</u>	<u>March</u>
<u>1949</u>		
Location		Micro-microcuries per liter* uuc/liter
Above 100-B Area		< 50
100-B Area		< 50
100-D Area		580
100-F Area		608
Hanford North Bank		667
Hanford Middle		1158
Hanford South Bank		1943
300 Area		311
Richland		461
Pasco		194
Yakima River (mouth)		< 50
Yakima River (Horn)		< 50

* The normal reporting level for the beta-gamma emitters in a 500 ml. river sample is currently established at 50 uuc/liter (5×10^{-5} uc/liter).

Analysis of weekly river water samples taken from twelve locations along the banks of the Columbia showed a general increase in the average beta activity detected in the river samples when the results were compared with those of the previous quarter. This increase is a direct effect of the low river flow encountered at this time of the year and results in subsequent lower dilution effect of river water to 100 area radioactive liquid effluent.

The increased beta-gamma activity in river water was quite noticeable at locations in the river from 100-D Area to Richland. The greatest increase was observed at the 100-D Area where the average beta activity in the river was about 580 $\mu\text{pc/liter}$ as compared with the average of 315 $\mu\text{pc/liter}$ during the previous quarter. The overall increase in the beta activity measured in the river samples during this quarter was consistent with a similar increase noted a year ago.⁽⁹⁾ Figure 8 is a bar graph summarizing the average beta-gamma activity measured in river samples taken from representative locations. A tabulated summary of an analysis of the trends in the river contamination during this period is included in the lower portion of Figure 8. The analysis also includes a comparison of the current quarterly average with the previous quarter.

It is of interest to note that again, at minimum river flow rate, the activity in samples from the south bank of the river was significantly higher than that in samples from the middle and north bank of the river. Samples from the middle of the river indicated the average beta activity to be about twice that amount detected in samples taken from the north bank. As postulated in previous reports, the distribution of the radioactive contamination in the river apparently changes with the changing flow rates, more uniform mixing being experienced during the high river flow period. To portray the change in the activity in the river with the changing flow rate of the Columbia River, a summary of the past three years

observations made during the first quarterly period is presented on Figure 9. This graph includes the average beta-gamma activity measured in the river samples with the corresponding flow rates of the Columbia River. The tabulation indicates a nearly identical ratio of difference between the locations tested during the first quarterly period of 1947 and 1949. The measured flow rates during these two years also appear to be somewhat similar. At low flow rates, samples from the south bank of the river at Hanford indicated the average beta activity to be about three times greater than that on the north bank; the activity in samples from the north bank was less than that found in samples from the middle of the river by a factor of two. This tabulation also indicates the effect of the shutdown of the 100-B Area in 1948; the measured activity was considerably lower at all sampling locations in the river after the shutdown.

An attempt to determine, qualitatively, the distribution of the radioactive contamination in the Columbia River between Pasco and Richland resulted in two surveys of the river on January 5 and 6. A total of seventy-two samples were taken from the Columbia River in these surveys. During the surveys, the river flow was 328,000 gallons per second; the operating conditions in the 100 Areas were normal. The sampling method consisted of taking three 500 ml. samples; one from near each shoreline and one from the middle of the river at intervals of about every mile along the river. At each location, a sample was also drawn from the surface, the middle, and just at the bottom of the river.

Measurements for the beta-gamma emitters in these samples indicated that the average activity varied from 130 to 260 $\mu\text{pc/liter}$; the average activity in all samples was 180 $\mu\text{pc/liter}$. Analysis of the data, comparing the contamination levels at various depths with the given locations indicated no significant difference from the amount of beta activity found in samples taken from the surface,

the middle, and bottom of the river. By comparing each individual activity value with the overall average, it was found that no real significant difference existed between any of the individual results with the mean value of all the samples. From this, it was then concluded that the mixing of the activity in the river in the area between Richland and Pasco was relatively uniform when the river was flowing at the rate of about 328,000 gallons per second.

A similar survey was made of the Columbia River covering the area between 100-B Area and 300 Area in late February, 1947. Ninety 500 ml. samples were taken in a similar manner to that described in the Richland-Pasco river survey except that sampling spots were taken at intervals of about five miles. No conclusions were drawn on the surface and varied depth samples as later consideration indicated dilution of the depth samples with other river water as the original sample was being drawn to the surface. Statistical analyses of the results of the radiochemical assays of the river samples indicated significant differences between locations, the degree of difference between samples at a given location in the river increasing as the sampling approached the 100-F Area. From these data, it was concluded that the distribution of the radioactive contamination was not uniform in this general area, the degree of non-uniform mixing increasing in magnitude as one approached the operating areas in the 100 Area. Figure 10 is a map showing the estimated distribution of the activity in the river as extrapolated from the results of the analyses of the ninety samples taken. This estimated distribution is for the given river flow only; differences in this pattern are expected for different river flow rates.

Absorption in aluminum and decay studies were made on some of the more active river samples noted in the river surveys previously discussed. The net results of a study of five samples indicated that about ninety-five per cent of the activity

was from 14.8 hour sodium (Na^{24}). (Some short half-lived Mn^{56} exists in the river, but generally this activity has decayed out before analyses are made on the river samples.) About two to five per cent longer half-lived beta emitters (principally Po^{59} , P^{32} , Ca^{45} , Cr^{51} , etc.) were measured in the river samples, the higher percentage detected in the samples taken from just below Hanford.

The river samples were also analyzed for total alpha activity from uranium and plutonium by the ether-extraction method; the average alpha activity in all the river samples was less than 6 dis/min/liter. Spot checks for uranium activity using the fluorophotometer method indicated that activity to be less than 4 $\mu\text{g/liter}$ in the samples analyzed.

Figure 11 shows the locations on the Columbia River, where the routine 500 ml. samples are taken at least once each week.

SECTION III

(See Table III, Figures 7,8,9,10,and 11)

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BETA CONTAMINATION
in
COLUMBIA RIVER
JANUARY-FEBRUARY-MARCH
1949

FIGURE 8

MICRO-MICROCURIES PER LITER

	ABOVE 100-B NO. 1	ABOVE 100-B NO. 2	181-B	181-D	181-F	HANFORD SOUTH BANK	HANFORD MIDDLE	HANFORD NORTH BANK	300 AREA	RICHLAND MIDDLE NO. 1	RICHLAND MIDDLE NO. 2	PASCO-KENN BRIDGE
ABOVE 100-B No. 1	△		△	△	△	△	△	△	△	△	△	△
ABOVE 100-B No. 2		↔	△	△	△	△	△	△	△	△	△	△
181-B	△	△	△	△	△	△	△	△	△	△	△	△
181-D	△	△	△	↑		△	△	△	☆☆		☆☆	☆☆
181-F	△	△	△		↔	☆☆			△	△	△	☆
HANFORD SOUTH BANK	△	△	△	△	☆☆	↑	☆☆	☆☆	△	△	△	△
HANFORD MIDDLE	△	△	△	△		☆☆	↔	☆	△	△	△	△
HANFORD NORTH BANK	△	△	△	△		☆☆	☆	↔	△	△	△	☆
300 AREA	△	△	△	☆☆	△	△	△	△	↔			
RICHLAND MIDDLE No. 1	△	△	△		△	△	△	△		↔	☆☆	☆
RICHLAND MIDDLE No. 2	△	△	△	☆☆	△	△	△	△		☆☆	↑	
PASCO-KENN BRIDGE	△	△	△	☆☆	☆	△	△	☆		☆		△

- △ CURRENT VARIANCE INVALIDATES TEST
 ☆ CURRENT DIFFERENCE APPROACHES SIGNIFICANCE
 ☆☆ CURRENT DIFFERENCE HIGHLY SIGNIFICANT
 ↔ NO SIGNIFICANT CHANGE SINCE PREVIOUS QUARTER
 ↑ QUESTIONABLE INCREASE SINCE PREVIOUS QUARTER
 ! SIGNIFICANT INCREASE SINCE LAST QUARTER
 □ NO SIGNIFICANT DIFFERENCE BETWEEN CURRENT AVERAGES

BETA ACTIVITY IN COLUMBIA RIVER
JANUARY—FEBRUARY—MARCH
1947—1948—1949

FIGURE 9

COLUMBIA RIVER FLOW

ESTIMATED DISTRIBUTION
BETA-GAMMA ACTIVITY
IN
COLUMBIA RIVER
MARCH 1949

FIGURE 10

[illegible]

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SECTION IVALPHA AND BETA-GAMMA CONTAMINATION IN DRINKING WATER AND TEST WELLS

During this quarterly period, over eight hundred drinking water samples were taken on and off the Hanford Project for radioactive contamination analyses. Figure 14 illustrates the approximate location where the drinking water samples were taken. In general, most locations are sampled once each week, however, a few of the key locations were sampled daily. Most of the samples were 500 ml. samples; in some cases where increased sensitivity was desired (about 1 dis/min/liter) 12 liter samples were taken.

The beta-gamma emitters were measured in all the 500 ml. samples. This measurement was made by mounting the residue of the evaporated water sample on a flat 1-1/2 inch diameter stainless steel plate and counting the activity from the sample using thin mica-window counters (window thickness varies between 3 to 5 $\mu\text{g}/\text{cm}^2$). The counting rates were corrected for counter geometry and decay when known. The alpha activity from plutonium and uranium in a sample was then made by transferring the residue from the stainless steel plate to a beaker and performing a modified ether extraction using aluminum nitrate as the "salting out agent" on the residue; the activity in the residue was measured by use of a 52 per cent geometry, parallel plate, standard alpha counter. The counting rates were corrected for geometry and overall extraction efficiency obtained by comparing the results with those obtained by analyzing control water samples to which known quantities of plutonium or uranium were added.

The results of the radiochemical analyses of the drinking water indicated levels of activity comparable with the results of the survey of the previous three months. In general, the beta-gamma activity in the drinking water of the Pasco-Kennewick Area averaged between 50-60 $\mu\text{c}/\text{liter}$; some occasional samples indicated

values as high as 200 $\mu\text{uc/liter}$. These trace amounts of activity fluctuate and are directly related to the activity in the Columbia River, which is the source of supply for most of the drinking water in Pasco and Kennewick. Decay studies of some of these water samples indicated that over ninety per cent of the activity detected was from 14.8 sour sodium (Na^{24}). Minute trace quantities of beta-gamma emitters were detected in samples from two Richland Wells and three 3000 Area Wells; this activity was of the order of about 10 $\mu\text{uc/liter}$. The identity of the specific emitter or emitters is not known.

The results of all the analyses for radioactive contamination in drinking water samples where detectable activity was noted are tabulated in Tables IV and V. Table IV summarizes the results of the analyses of the 500 ml. samples where the detection limit for the beta-gamma emitters is about 10 $\mu\text{uc/liter}$ and for alpha activity from plutonium and uranium, 6 dis/min/liter. The sensitivity limit for alpha activity in the 12 liter water samples is about 1 dis/min/liter; the measurements for beta-gamma activity in the large volume water samples are essentially sensitive to about 10 $\mu\text{uc/liter}$ which is identical to the 500 ml. samples as direct counts are made on the residue of an aliquot of the 12 liter sample. Each table includes the total number of samples, taken from each location, the average activity detected in the samples and the maximum individual value both for the beta-gamma and alpha activity. In general, it can be stated that the overall results did not differ significantly from the results obtained in the surveys of the previous three months with only minor fluctuations occurring at some of the locations sampled.

The maximum alpha activity detected in any sample was 52 dis/min/liter taken from the Benton City Water Company Well; the maximum average alpha activity detected in samples from the given locations was 29 dis/min/liter; this was detected

in the water samples taken from the Chevron Standard Station in Benton City. The alpha activity in these wells was confirmed to be primarily from uranium, presumably occurring in natural amounts in the wells; the specific analyses for uranium is performed by the fluorophotometer method which should be sensitive to about 4 μg U/liter of solution. Figure 12 summarizes the radiochemical analytical results of Benton City drinking water which is a representative area indicating the highest background level of alpha activity in the drinking water supplies of this general area. The results indicate that the alpha activity is principally from uranium with the general level of activity in the three locations sampled within Benton City proper to be essentially the same. Samples taken at Cobbs Corner, about 3 miles away from the other three sampling locations, indicated a significantly lower level of activity. The limit of sensitivity shown on the graph applies to a single 500 ml. sample; the limit of sensitivity from the 3 gallon samples is about 1 dis/min/liter.

Figure 13 is a summary of the alpha activity detected in samples from representative locations in Richland and is compiled in a similar manner as shown for the Benton City water supply. The level of activity in the Richland water was decidedly lower than that found in the Benton City Wells. The slight differences noted in activity measurements made on the 500 ml. and 3 gallon is believed to be primarily from errors in the laboratory procedures rather than environmental induced differences.

Samples were also taken from the drinking water in the 100 and 200 Areas; the source of supply for this drinking water is the Columbia River. The river water is pumped from either of the three 100 Areas for local use in those areas and piped from the 100 Areas to the 200 Areas for consumption in the separations area. Samples were taken at least once each week from a representative location in each

area. The results of the analyses of these samples are summarized in Table VI:

Table VI
AVERAGE ALPHA AND BETA ACTIVITY MEASURED IN
SANITARY AND RAW WATER
1949
HANFORD WORKS

Location	RAW WATER		SANITARY WATER	
	Alpha Activity dis/min/liter	Beta Activity μ uc/liter	Alpha Activity dis/min/liter	Beta Activity μ uc/liter
100-B Area	< 6	< 10	< 6	< 10
100-D Area	< 6	83	< 6	< 10
100-F Area	< 6	120	< 6	23
200-East Area	< 6	23	< 6	< 10
200-West Area	< 6	30	< 6	< 10

The raw water is the river water as taken directly from the sampling ports in the 183 buildings of the 100 Areas and from the 283 buildings in the 200 Areas. The sanitary water is taken directly from drinking water fountains. The results are in the order of magnitude expected with minimum activity levels at the 100-B Area (< 10 μ uc/liter) and increasing in concentration as one approaches the 100-F Area where the average beta-gamma emitters detected was 120 μ uc/liter. This activity is primarily from 14.8 hour sodium (Na^{24}) as shown by decay studies. The levels of activity in the 200 Areas are slightly lower (~20-30 μ uc/liter) and represent a decay period in piping the water from the 100 areas to the 200 areas. Positive activity was detected in the drinking water at 100-F Area only, and for Na^{24} , the value of 23 μ uc/liter noted in the drinking is far below the permissible concentration for that isotope in drinking water. Measurements for alpha activity in all of these water samples using the ether-extraction method indicated less than 6 dis/min/liter from plutonium and uranium.

SECTION IV
(See Figures 12, 13, 14, and Tables IV, V, and VI)

Table IV

SUMMARY OF ALPHA AND BETA GAMMA ACTIVITY MEASURED IN DRINKING WATER500 ml. samplesJanuary - February - March1949

Location	No. Samples	ALPHA ACTIVITY		BETA-GAMMA ACTIVITY	
		dis/min/liter		mc/liter	
		MAXIMUM	AVERAGE	MAXIMUM	AVERAGE
Richland #2	12	24	10	22	<10
Richland #4	10	23	11	<10	<10
Richland #5	10	9	<6	<10	<10
Richland #12	12	17	6	<10	<10
Richland #13	48	27	9	11	<10
Richland #14	11	20	9	<10	<10
Richland #15	10	27	16	14	<10
Richland #18	2	11	8	<10	<10
Tract House K-748	13	9	<6	11	<10
Tract House J-685	13	19	<6	16	<10
3000 Area Well A	9	8	<6	10	<10
3000 Area Well B	2	6	<6	13	11
3000 Area Well C	9	13	<6	<10	<10
3000 Area Well E	10	12	<6	<10	<10
3000 Durand #5	12	9	<6	<10	<10
Headgate	13	10	<6	10	<10
Hanford	6	10	<6	<10	<10
Columbia Camp	13	9	<6	<10	<10
Benton City Store	3	30	23	<10	<10
Benton City Chevron Station	7	44	29	<10	<10
Benton City Water Company	12	52	26	10	<10
Cobbs Corner	13	13	<6	<10	<10
Enterprise	2	12	<6	<10	<10
Kennewick Texaco Station	3	<6	<6	70	49
Kennewick 614 Building	4	<6	<6	134	58
Kennewick Standard Station	11	7	<6	127	54
Riverland	12	11	<6	10	<10
Midway	12	11	<6	10	<10
Wills Ranch	7	10	<6	<10	<10
Pasco	10	10	<6	191	58
Pistol Range	13	12	<6	18	<10
White Bluffs	39	26	15	53	<10

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Table V

SUMMARY OF ALPHA AND BETA-GAMMA ACTIVITY MEASURED IN DRINKING WATER BY12 Liter SamplesJanuary - February - March1949

Location	No. Samples	ALPHA ACTIVITY		BETA-GAMMA ACTIVITY	
		dis/min/liter		µuc/liter	
		MAXIMUM	AVERAGE	MAXIMUM	AVERAGE
Richland #2	5	14	9	<10	<10
Richland #4	3	12	8	<10	<10
Richland #5	4	5	4	<10	<10
Richland #12	4	9	5	<10	<10
Richland #14	4	8	6	<10	<10
Richland #13	5	7	4	<10	<10
Richland #15	4	10	7	<10	<10
Richland #16	5	5	3	<10	<10
Tract House K-748	5	4	3	<10	<10
Tract House J-685	5	7	3	<10	<10
3000 Area Well A	3	6	3	<10	<10
3000 Area Well B	1	5	5	<10	<10
3000 Area Well C	5	3	2	16	<10
3000 Area Well E	4	3	3	<10	<10
3000 Area Durand #5	5	5	3	<10	<10
Headgate	5	3	1	<10	<10
Riverland	4	5	2	<10	<10
Pistol Range	5	7	4	<10	<10
White Bluffs	4	17	15	<10	<10
Benton City	4	20	14	<10	<10
(Chevron Station)					
Benton City Water Company	4	34	24	<10	<10
Cobbs Corner	6	6	4	<10	<10
Kennewick	2	1	1	27	20
(Texaco Station)					
Kennewick	5	2	1	<10	<10
(Standard Station)					

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ALPHA ACTIVITY

FIGURE 13

in
RICHLAND DRINKING WATER
JANUARY—FEBRUARY—MARCH
1949

50

45

40

35

30

25

20

15

10

5

0

SCALE

LIMIT OF SENSIBILITY

FIGURES ABOVE COLUMNS INDICATE NUMBER OF SAMPLES.

ALPHA ACTIVITY
DIS/MIN/LITER
3 GALLON SAMPLES
(ETHER EXTRACTIONS)

ALPHA ACTIVITY
DIS/MIN/LITER
500 CC. SAMPLES

U. ACTIVITY
µg/LITER
(FLUOROPHOTOMETER)

FIGURE 14

- WELLS**
- 1. NEGERSON'S RANCH
 - 2. LOWER KNOB
 - 3. MIDWAY
 - 4. WILL'S RANCH
 - 5. RIVERLAND
 - 6. WB 01439
 - 7. WB 01440
 - 8. WHITE BLUFFS R-1515
 - 9. PISTOL RANGE
 - 10. FOSTER'S RANCH
 - 11. HANFORD WELLS (1,4,9 CITY)
 - 12. COLUMBIA CAMP
 - 13. HEADGATE
 - 14. TRACT HOUSE J-685
 - 15. ENTERPRISE
 - 16. 300 AREA SANITARY
 - 17. 3000 RANNEY D
 - 18. 3000 DURAND NO 1
 - 19. 3000 RANNEY E
 - 20. 3000 DURAND NO 2
 - 21. TRACT HOUSE N 748
 - 22. RICHLAND DURAND NO 16
 - 23. BENTON CITY (2 WELLS)
 - 24. COBB'S CORNER
 - 25. KENNEWICK CITY SUPPLY
 - 26. HANFORD NO 7
 - 27. HANFORD NO 7 SANITARY
- TEST WELLS**
- A. MEER
 - B. FORGE
 - C. WAGE
 - D. RANCH 13
 - E. 200 NORTH NO 5
 - F. SPRING 13
 - G. RATTLESNAKE SPRING
 - H. BENSON RANCH
 - J. SNIVELY RANCH
 - K. B-Y
 - L. 300 AREA NO 1
 - M. 300 AREA NO 2
 - N. 300 AREA NO 3
 - O. 500 AREA NO 4
- *** NOT IN USE
** OCCASIONALLY USED FOR DRINKING WATER

HANFORD WORKS	
SAMPLING LOCATIONS	
DRINKING WATER & TEST WELLS	
JANUARY 1949	
H. I. DEVELOPMENT DIVISION — SITE SURVEY	DRAWN BY E. L. K.
DATE 8-8-49	CHECKED

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SECTION V

BETA CONTAMINATION IN RAIN

One hundred and ninety-three rain samples were collected from twenty-eight locations on and adjacent to the project during the period January to March, 1949. The total amount of precipitation throughout this period was 1.93 inches; during this period last year the rainfall was 2.12 inches. In previous years, the bulk of the rainfall in the first quarterly period occurred in January; the minimum quantity of rain falling during March. In the current quarterly period, however, most of the rain fell during March. The total rainfall for the entire period was relatively normal, however, and the usual number of rain samples were collected for analyses. The tabulation below summarizes the rainfall conditions observed during this quarterly period the past years:

<u>RAINFALL - HANFORD WORKS</u>				
<u>Inches of Precipitation</u>				
<u>MONTH</u>	<u>35 YEAR AVERAGE</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>
January	0.85	0.32	1.36	0.13
February	0.63	0.27	0.69	0.68
March	<u>0.33</u>	<u>0.42</u>	<u>0.07</u>	<u>1.12</u>
TOTAL	1.81	1.01	2.12	1.93

An analysis of the results obtained for the beta activity measurements in rain samples indicated no significant trends or changes in the level of radioactive contamination detected in the rain samples. The range of beta activity in rain samples collected within the separation areas was between 1.0 m μ c/liter and 20.0 m μ c/liter; occasional samples were as high as 60 m μ c/liter collected near the base of the stacks. The average beta activity detected in rain samples at distances between two and twenty miles from the stacks indicated very little deviation from each other with one exception where a sample collected

in the 3000 Area indicated 120 m μ c/liter. This sample was radio-autographed and showed no evidence of particle deposition. The average beta activity detected in rain collected outside the project perimeter was less than 1.0 m μ c/liter at all locations. The maximum activity found in this latter group was 1.4 m μ c/liter detected in a sample collected in the village of Richland.

Figure 15 summarizes the average beta activity detected in the rain samples from the listed grouped locations. Figure 16 shows the rain gauge stations where the rain samples are normally collected after each rainfall in the area.

Section V

(See Figures 15 and 16)

15

3-4	INCL	200 WEST AREA
5	NCCL	200 EAST AREA
6		METEOROLOGY
7		N-40 WHITE
8		300 AREA 6-4 BLDG
9		2-4 AREA 6-4 BLDG
10		PASCO HWY POINT
11		HENTON CITY 614 BLDG
12		13-1 H SE CORNER
13		13-1 H SE CORNER
14		13-1 E SW CORNER
15		13-1 E SW CORNER
16		MANFORD 614 BLDG
17		RIVERLAND 614 BLDG
18		200 NORTH AREA 614 BLDG
19		BENSON RANCH
20		GABLE MT TOWER
21		TEMPORARY INSTALLATION)
22		234-5 TEMPORARY INSTALLATION)
23		MANFORD 101 BLDG
24		WHITE BLUFFS
25		100-DR
26		3000 AREA SOUTH
27		3000 AREA NORTH
28		
29		
30		
31		
32		
33

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SECTION VIBETA-GAMMA CONTAMINATION ON VEGETATION

The quantity of eight day iodine and 5.4 day xenon calculated to be present in the dissolver units based on the weight and cooling time of the irradiated uranium during the period January, February and March, 1949, is tabulated below:

Month	200 East Area		200 West Area		Total	Curies
	Curies I ¹³¹	Curies Xe	Curies I ¹³¹	Curies Xe	I ¹³¹	Xe
January	312	18	225	15	537	33
February	67	3	341	15	408	18
March	178	6	476	19	354	25

The above values are only included to serve as a basis of comparison between the amount of radioactive gases formed during this period with other periods and do not represent the amount of radioactive gas that was actually liberated into the atmosphere.

A graph showing the daily calculated quantities of I¹³¹ formed during the metal dissolution is presented on Figure 19. The cooling time for the uranium dissolved during this period varied from about 85 days to 105 days. Estimates of the I¹³¹ and filterable beta activity expelled from the stacks as determined by sampling an aliquot of stack gas and passing it through a filter paper and an iodine scrubber solution indicate that about $\frac{1}{2}$ to 1 curie of radioactive gas is expelled to the atmosphere daily. About fifteen hundred vegetation samples were collected in the environs of the Hanford Works during this quarter. Each vegetation sample was analyzed for the beta activity from eight day iodine (I¹³¹), and for the beta activity from the longer half-lived "non-volatile" fission product elements.

The method of analysis for I¹³¹ in vegetation consisted of digesting a 5 gram sample of vegetation in a 0.2 N sodium hydroxide-sodium bisulphite solution and filtering off the fibrous vegetation remaining after the digestion. The filtrate was treated with aluminum nitrate and centrifuged to remove any remaining organic material.

The I^{131} was removed from the supernatant as a precipitate in the form of silver iodide. The precipitate was mounted on a 1 inch diameter filter paper and the activity was measured by means of a 3-5 mg/cm² mica-window counter. Control vegetation samples to which known quantities of I^{131} were added, were run simultaneously with the regular vegetation samples; this data indicated that about 65-70 per cent yield can be expected for this type of analysis. All the raw data was corrected for counter geometry, overall extraction efficiency, and decay. The limit of sensitivity for this analysis is about 2 m μ c I^{131} /kg vegetation.

The method of analysis for the non-volatile activity (long-half-life) consisted of a nitric acid hydrogen peroxide (30% H₂O₂) digestion of a representative one gram sample of vegetation. After digestion and concentration, the residue was quantitatively transferred to a one inch stainless steel plate and the activity measured using thin mica-window counters. Control data indicated a yield between 95% and 100% on this process for about 1.5 MEV beta emitter. The total beta activity measured in this manner would include any beta activity from the natural occurring isotope of potassium (K^{40}) present in the potassium salts of the vegetation. Preliminary estimates indicated that the average activity from K^{40} in the vegetation of this area is approximately 10 m μ c/kg; hence, this level of activity is currently considered as the background level of the activity in the vegetation.

A summary of the measured I^{131} activity in vegetation samples taken from representative locations during this quarter is shown on Figure 17. The maximum average concentration of I^{131} deposited on the vegetation was 383 m μ c/kg; this was detected at a point downwind from the 200 West Area Stack and about one mile from the stack. This area is just outside the perimeter fence near the gatehouse of 200 West Area. The detection for the maximum ground concentration of I^{131} at this point is relatively consistent as found in reviewing the data for the past two years. The maximum I^{131} concentration on vegetation detected inside the 200 West and 200 East Areas was 331

and 160 m μ c/kg, respectively. Three month average activity from I¹³¹ outside the 200 West Area was about 383 m μ c/kg as compared with the average of 44 m μ c/kg inside the area. The general deposited I¹³¹ activity on vegetation falls off abruptly within a zone approximately 1 mile northwest and approximately five miles southeast of the separations area stacks; the average activity on vegetation from I¹³¹ being in the range of 5 to 20 m μ c/kg. The detectable I¹³¹ on vegetation at the Hanford Works followed the pattern of the prevailing wind with reasonably good agreement. Figure 22, is an iso-activity map showing the estimated distribution of I¹³¹ on vegetation in the Hanford Works and environs; a wind rose summarizing the wind directions during dissolving hours is also shown on the graph.

Figure 17, is a bar graph listing the average I¹³¹ detected on vegetation at the key sampling locations.

Measurements for the longer half-lived fission products (non-volatile activity) expelled from the separation area stacks and deposited on vegetation were also made. The non-volatile activity on the vegetation at the maximum ground concentration point (just outside the 200 West Area gatehouse) was 240 m μ c/kg. Measurements made inside the separation areas indicated an average deposition of non-volatile activity of 72 and 51 m μ c/kg in the 200 East and 200 West Areas, respectively. The maximum non-volatile activity detected on an individual vegetation sample was 600 m μ c/kg found outside the 200 West Area near the gatehouse. About three miles from the separation areas a significant decrease in activity from the non-volatile emitters was noted; the activity at this point varying between 20 to 60 m μ c/kg. Figure 18, is a bar graph summarizing the average non-volatile activity detected in vegetation at the key sampling points. Figure 23, is an iso-activity chart showing the estimated distribution of the longer half-lived non-volatile fission products deposited on vegetation; this pattern follows the pattern obtained in I¹³¹ iso-activity chart; both of which are

principally influenced by the wind directions in the area.

Approximately 180 vegetation samples were collected from the residential communities of Richland, Pasco, Kennewick, and the Richland 'Y'. The average beta activity from eight day iodine detected in the vegetation from this region was about 2 mpc/kg; the average beta activity from non-volatile emitters being less than 10 mpc/kg. The maximum I^{131} activity detected on any vegetation sample in this region was 10 mpc/kg, the maximum non-volatile activity detected in the same area was 32 mpc/kg, both samples were collected in the vicinity of Richland. The average beta activity detected on vegetation in the Pasco-Kennewick area was below the detection limit of 2 mpc I^{131} /kg and 10 mpc non-volatile activity/kg.

A statistical comparison of the average activity on vegetation in the residential areas indicated no significant difference in the deposited activity on vegetation when any given section was compared with the other residential sections surveyed.

One complete survey for radioactive contamination on vegetation in the Wahluke Slope region was completed during this quarter. The average beta activity detected was less than 2 mpc I^{131} /kg vegetation; occasional samples indicated 5 to 6 mpc/kg which tended to confirm the spotty deposition of I^{131} in small areas of the Wahluke Slope observed in past surveys. A statistical comparison of the detected activity in these spotty areas with the overall average deposition indicated that the small local areas were significantly higher than the overall average. The occasional deposition of activity noted on the vegetation in the Wahluke Slope is a function of the rate of emission of stack effluent and the cross over wind directions brought about by the different wind conditions observed at 200 West Area and the wind directions near the 100 Areas (Figure 3, Section I). Beta activity from the non-volatile emitters averaged about 12 mpc/kg on the vegetation; the individual maximum result was 30 mpc/kg. A statistical comparison of the average non-volatile beta activity measured on Wahluke Slope with the activity measured on vegetation from Richland, indicated that the

activity on the Slope is higher. It should be noted, however, that thorough background measurements for beta activity from K^{40} in vegetation from Wahluke Slope and Richland areas have not yet been completely resolved and some variations and differences in activity from this natural occurring isotope are possible.

Surveys of the MP posts in the vicinity of Rattlesnake Mountain indicated that the average I^{131} activity on vegetation was 6 $\mu\text{mc}/\text{kg}$ and the non-volatile beta activity was about 12 $\mu\text{mc}/\text{kg}$. The activity from the longer half-lived isotopes on vegetation in the Rattlesnake region was found to be significantly higher than that observed on the vegetation in Richland.

In addition to the vegetation surveys made on the project proper, surveys were also taken at offsite locations. These surveys included the Finley, Hover, Ringold, Dayton, and Ellensburg communities. The results of these surveys indicated the overall average activity to be below the detectable quantities of 2 $\mu\text{mc } I^{131}/\text{kg}$ and 10 μmc non-volatile activity/kg. Although, the levels of activity noted in these surveys were below the detectable quantities as established for an individual sample, by averaging the results of many samples, some significance can be assigned to the grouped readings and by a study of these grouped data it was hoped that deposition trends would be indicated. Studies of this nature show that the beta activity in remote regions around Pasco were lower than the average activity measured in Richland. The results from the off area sampling were compared with the average activity in Pasco; the results of this data comparison are tabulated below:

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TABLE VII
COMPARISON OF BETA ACTIVITY MEASUREMENTS ON VEGETATION IN
RESIDENTIAL AREAS

Locations Compared	January	February	March
	Average ^{131}I Activity	Average Activity from Non-Volatiles	Results of Statistical Comparison
Pasco City	1.7 m μ c/kg	8 m μ c/kg	No significant difference in activity deposition.
Pasco to Eltopia	1.4 m μ c/kg	7 m μ c/kg	
Pasco City	1.7 m μ c/kg	8 m μ c/kg	^{131}I in Pasco significantly higher. No difference in non-volatile levels.
Kennewick-Finley-Hover	1.0 m μ c/kg	7 m μ c/kg	
Pasco City	1.7 m μ c/kg	8 m μ c/kg	No difference in activity deposition.
Pasco to Ringold	1.7 m μ c/kg	8 m μ c/kg	
Pasco City	1.7 m μ c/kg	8 m μ c/kg	Pasco significantly higher for both analysis.
Pasco to Dayton	0.2 m μ c/kg	5 m μ c/kg	
Pasco City	1.7 m μ c/kg	8 m μ c/kg	Yakima Ellensburg significantly higher than Pasco in non-volatile activity.
Yakima Barricade-Ellensburg	0.9 m μ c/kg	10 m μ c/kg	

* Includes natural activity from isotope of potassium (K^{40}) present in the potassium of vegetation.

The above results indicate that there are significant differences in the average activity from the non-volatile emitters when Pasco is compared with some of the other locations. The data also indicate that the activity from ^{131}I on vegetation in Pasco is greater than that noted in Kennewick and towards Dayton. Because of the low levels involved, these trends are not certain but it does tend to indicate that there are minute quantities of radioactive stack gases deposited in Pasco as indicated by the trends shown in the above table. Here again, the measurements for activity from the non-volatile emitters must be qualified, in view of the fact that variations of the activity in the vegetation due to the varying quantities of natural occurring K^{40} is not thoroughly known at the present time. Figure 20, summarizes the detailed results of the off area vegetation survey covering the area enclosed by Ellensburg, Yakima, Sunnyside, and the Yakima Barricade. Statistical analyses indicated that these levels of activity noted in the off area surveys were not significantly different from that noted in the surveys around Richland.

In an effort to determine specific patterns of deposition of radioactive effluent from the separation area stacks, controlled sampling of vegetation in and near the areas was initiated. The first survey was taken early in February; vegetation samples were taken at half mile intervals in an area enclosing about twenty-six square miles in and near the separation areas. A similar survey was made in March; in both surveys, all samples were analyzed for I^{131} and non-volatile beta activity. The results of these surveys are illustrated on Figure 21, which summarizes the beta results by means of an iso-activity chart in which the distribution of the deposited activity is estimated. The controlled sampling clearly indicated that the deposition pattern is a function of the operating condition and wind direction. As anticipated, the pattern for the deposition of I^{131} varied from month to month while the pattern for deposition of the longer half-lived elements remained relatively constant. The overall pattern for the estimated distribution of the longer half-lived isotopes is representative of the overall predominant average deposition of the radioactive effluent from the 200 Area stacks; this deposition pattern corresponds to the pattern obtained by the present random sampling of vegetation for I^{131} activity. The controlled sampling indicated that the current sampling method employed in evaluating the average deposition of eight day iodine and the non-volatile fission products on vegetation is satisfactory. Figures 24 and 25 are sampling location maps indicating where vegetation samples are taken approximately once a week within the perimeter of the Hanford Project.

SECTION VI

(See Figures 17,18,19,20,21,22,23,24,25,& Table VII)

EXTENT ¹³¹I CONTAMINATION
ON
VEGETATION
HANFORD WORKS & VICINITY
JANUARY - FEBRUARY - MARCH
1949

FIGURE 17

EXTENT NONVOLATILE BETA CONTAMINATION ON

VEGETATION
HANFORD WORKS & VICINITY
JANUARY-FEBRUARY-MARCH
1949

FIGURE 18

MILLI-MICROCURIES PER KILOGRAM

110
100
90
80
70
60
50
40
30
20
10
0

PASCO	10
KENNEWICK	10
RICHLAND "Y"	10
BENTON CITY	10
RICHLAND	10
COLUMBIA CAMP	10
BENSON RANCH	10
RATTLESNAKE SPRING	10
200-E AREA	70
622 BLDG. METEOROLOGY	80
200-W AREA	50
200-W GATE	240
HANFORD	10
GABLE MOUNTAIN	10
MIDWAY	10
RIVERLAND	10
100-B AREA	10
100-D AREA	10
100-F AREA	10

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CALCULATED ^{131}I IN URANIUM DISSOLVED
IN
SEPARATION AREAS
JANUARY - FEBRUARY - MARCH
1949

FIGURE 19

BETA CONTAMINATION ON VEGETATION
OFF AREA
MARCH 1949

FIGURE 20

NONVOLATILE BETA CONTAMINATION

¹³¹I CONTAMINATION

Scale: 1" = 18 Miles

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FIGURE 21

MARCH 1949

NONVOLATILE BETA CONTAMINATION

FEBRUARY 1949

MARCH 1949

¹³¹I CONTAMINATION

FEBRUARY 1949

FIGURE 22

FIGURE 23

FIGURE 25.

SECTION VIIALPHA AND BETA CONTAMINATION IN HANFORD WASTES100 AREAS:

Results for the alpha and beta contamination measured in samples of the effluent waters of the 107 retention ponds during the quarter January, February, and March, 1949, are summarized in the table below. The tabulation includes only those results which are representative of normal operating conditions in the 100 Areas.

Sample Location	Alpha Activity dis/min/liter		Beta Activity uc/liter	
	Maximum	Average	Maximum	Average
107-B	43*	< 30	0.39	0.30
107-D	46*	< 30	0.74	0.31
107-F	38	< 30	0.48	0.37

* Subsequent samples from these locations indicated <30 dis/min/liter.

Analysis of the above data indicated that the average beta activity detected in samples from the 107-F effluent water was higher than that detected in the 107-B and 107-D effluent water; also, the average beta activity measured in each of the basins was somewhat higher than that measured during the previous quarter. No single apparent cause can be assigned to explain this increase, however, previous data have indicated this range of fluctuation to exist within duplicate samples. The varying amounts of algae in the basin during the periods involved, along with the varying amounts of algae collected in the individual 500 ml. samples could account for the fluctuation in the beta activity detected in the water samples.

The retention pond samples were analyzed for uranium; only one result exceeded the detection limit of 4 ug/liter. Sufficient volume of this sample was not available for further analyses, although subsequent resamples did not confirm this activity.

The 107 retention pond samples were spot checked for plutonium and polonium; the results indicated < 6 dis/min/liter from either source.

Several samples of the 107 effluent water were analyzed for beta activity from ^{35}S , the activity averaged around 10 mpc/liter early in the quarter, and about

1.0 $\mu\text{c}/\text{liter}$ during late February and March. Samples obtained from the dryer room condensate at 100-B Area showed the S^{35} activity to average $0.7 \mu\text{c}/\text{ml.}$, with occasional maximums approaching $1.5 \mu\text{c}/\text{ml.}$

A survey of the 'C' ditch in the 100-F Area was made in early March. This ditch contains waste effluent from the 105 and 190 buildings. Maximum portable readings of 100 mrep/hr. at the inlet from the 105 building, and 60 mrep/hr. at the area perimeter fence were obtained. Water samples indicated about $50 \mu\text{c}/\text{liter}$ of beta activity, and 20 dis/min/liter for alpha activity.

200 AREAS:

The maximum results of portable instrument (VGM's) surveys of the three 200 North area ditches were 32,000 counts/minute and 8.5 mrep/hour (Beckman). These values are consistent with survey results from previous quarters.

Routine portable instrument surveys of the 'T' Ditch 'T' Swamp, and the Laundry Ditch in the 200 West Area showed the readings to vary from background (50 counts/minute), to a maximum of 700 counts/minute.

Routine VGM probe surveys of the test holes around the 200 West Area waste lines resulted in positive readings of from 2 to 10 times the normal background of 50 counts per minute for test holes "B" and "E". These readings are in agreement with previous surveys. The remaining test holes were at background levels.

The following table summarizes the alpha and beta contamination measured in samples obtained from the 241 "T" Swamp in the 200 West Area:

Location & Type Sample	Total Beta Activity muc/liter		Total Alpha Activity dis/min/liter	
	Maximum	Average	Maximum	Average
T Swamp, Inlet	0.43	0.11	42	<30
T Swamp, West Side	0.20	0.10	45	<30
T Swamp, South Side	0.43	0.11	1100	<30*
Mud Sample	uc/kg		dis/min/kg	
T Swamp, West Side	0.05	0.03	1.2×10^5	6×10^4
T Swamp, South Side	0.07	0.03	2.7×10^5	1×10^5

*Does not include result of 1100 dis/min/liter, which was the only result above the reporting level of 30 dis/min/liter.

No significant changes were noted in the current contamination level with those of the previous quarter. The water sample levels are almost identical to those of the previous quarter, while the mud sample results are slightly lower. The one alpha result of 1100 dis/min/liter is unusual but not unprecedented. Analysis of this sample for uranium by the fluorophotometer process yielded a result of 1200 micrograms of uranium per liter. This indicates that the total activity was from uranium.

A summary of the alpha and beta contamination detected in samples from the 'U' Swamp in the 200 West Area and those ditches flowing into the swamp is tabulated below:

Location	Total Beta Activity muc/liter		Total Alpha Activity dis/min/liter	
	Maximum	Average	Maximum	Average
Laundry Ditch, Inlet	2.32	0.44	200	55
600' From Inlet	0.27	0.12	700	180
231 Ditch, Pipe Outlet	0.08	0.03	50	<30
1st. Underpass	1.90*	0.03	32	<30
'U' Swamp Inlet	0.96*	0.03	3000*	35
West Side	0.06	0.01	100	50

*These values were not included in their respective group averages as they were not confirmed by subsequent resamples.

The average beta contamination found in the Laundry Ditch this quarter was somewhat higher than last quarter, however the sample levels varied so widely that no significance in the difference was established. Fluorophotometer analysis indicated that trace quantities of uranium were present in this ditch with a maximum result of 100 μ g U/liter.

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The alpha and beta activity levels in the 231 Ditch approximate the minimum reporting levels of 50 micro-microcuries per liter for beta and 30 dis/min/liter for alpha. No significant change in these averages was noted when compared with the average over the past two years.

The increase in beta contamination noted in the Laundry Ditch for this quarter was reflected by an increase in the 'U' Swamp average beta activity for the same period. Although, the average beta activity was higher than last quarter by a factor of ten the more frequent results were below the limits of detection. The alpha activity in the swamp was slightly above the minimum reporting level but was considerably lower than similar activity detected in the Laundry Ditch. The maximum fluorophotometer result was 70 μg U/liter.

Lint samples collected in the vicinity of the Laundry Building in the 200 East Area indicated beta activity approaching 1.5 $\mu\text{c}/\text{kg}$ of lint and alpha activity of 1.1×10^6 dis/min/kg of lint. Neither of these results were unusual when compared with the data of the previous quarter.

The average beta activity in the 271-B and 271-T Retention Basins was 0.08 and 0.13 $\mu\text{c}/\text{liter}$ with maximums of 0.15 and 0.40 milli-microcuries per liter, respectively. One sample from the 271-T Basin showed alpha activity of 40 dis/min/liter, this value being the only result above the reporting level of 30 dis/min/liter at this location.

300 AREA:

The maximum beta activity detected in samples of waste solutions from the new and old 300 Area Retention Ponds was 4.8 and 21.0 $\mu\text{c}/\text{liter}$ respectively. These values were consistent with those observed last quarter. Alpha activity maximums were 2.8×10^4 and 1.6×10^4 dis/min/liter, respectively. Fluorophotometer analyses showed uranium as the contaminant, occasional results as high as 1.6×10^4 μg U/liter were detected. Waste solid samples taken at the inlet of the old pond yielded maximum

values of 9.2 $\mu\text{c/kg}$ beta activity, and approximately 2.0×10^7 dis/min/kg for the alpha emitters.

Samples from the 300 Area Waste Line, which empties into the new retention pond, were taken almost daily during the quarter. The detected activity has the possibility of several sources, as this line carries all 300 Area waste to the ponds. The results reflect this fact as they show considerable fluctuation. The beta activity ranged from 0.01 to 1.0 $\text{m}\mu\text{c/liter}$ with a maximum activity of 6.6 $\text{m}\mu\text{c/liter}$. The maximum alpha result was 3.7×10^4 dis/min/liter. Fluorophotometer analysis established most of this activity to be from uranium, with the maximum result of $2.5 \times 10^4 \mu\text{g U/liter}$. Analysis of waste line samples for plutonium by the T.T.A. process showed one result of 100 dis/min/liter.

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