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RADIOACTIVE PARTICLES IN THE HANFORD ENVIRONS
NOVEMBER - DECEMBER
1952

By

H. J. Paas

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RADIOACTIVE PARTICLES IN THE HANFORD ENVIRONS NOVEMBER - DECEMBER 1952

INTRODUCTION

The Regional Survey forces of the Radiological Sciences Department operate more than 50 air monitoring stations in the Hanford environs for the specific purpose of determining the number of radioactive particles in the atmosphere. Data accumulated from these measurements, which represent the normal "fall-out" of radioactive particles from the Hanford effluent gases, have been published in periodic reports.[1, 2] Detailed reports summarizing data obtained during periods when excessive concentrations of radioactive particles were measured have been published in special reports.[3, 4, 5, 6] This document summarizes the results obtained during late 1952 when significant increases in the number of radioactive particles were observed in the immediate Hanford environs and throughout the Pacific Northwest.

SUMMARY

The results obtained from atmospheric monitoring and vegetation monitoring showed significant increases in particulate contamination during the months of November and December, 1952, at all stations in the immediate environs and at stations in Montana, Idaho, and Oregon. Daily monitoring showed extreme peak concentrations on four or five occasions during the period. The similarity of the dates on which the peaks were observed at different stations and the fact that in many instances the number of particles measured at remote locations exceeded the number of particles measured in the immediate environs indicated that the source of this contamination was not associated with the Hanford Atomic Products Operation.

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PROCEDURES

The number of radioactive particles in the immediate Hanford environs was measured at approximately 40 air monitoring stations located on the project. Most of these stations were located near the Separations Areas where the effluent gases from the process constitute a source of particulate contamination. Data collected at these stations were supplemented with measurements obtained at eleven remote stations located in Montana, Oregon, Washington, and Idaho. The remote stations were operated primarily for evaluating natural background and for confirming the influx of particulate contamination from sources other than the Hanford operation. A map showing the location of these stations may be referred to in Figure 1.

Air flows ranging from 2.5 cfm to 10 cfm were motivated through CWS #6 filter paper by 1/4 or 1/2 horsepower Motoair pumps at each monitoring station. The exposed surface of the filter was 28 sq in. for sampling rates in excess of 5 cfm and 9 sq in. for flow rates below 5 cfm. Radioactive particle concentrations were determined by radioautographing these air filters, which were exposed at the locations for daily or weekly periods. Air filters removed from stations in the immediate environs were normally radioautographed the day following removal from the station; samples obtained from remote locations were radioautographed 2 to 5 days after removal.

Normally, the filters are exposed to type K X-ray film for 168 hours; during periods of excessive particle concentrations, however, preliminary evaluations of the magnitude of the hazard were determined from the results of 24 hour exposures to the film. The number of radioactive particles on the filter was determined by visually counting the number of darkened spots on the developed film. Concentrations in the atmosphere were calculated by dividing the total number of darkened spots by the volume of air sampled and reported as the number of radioactive particles

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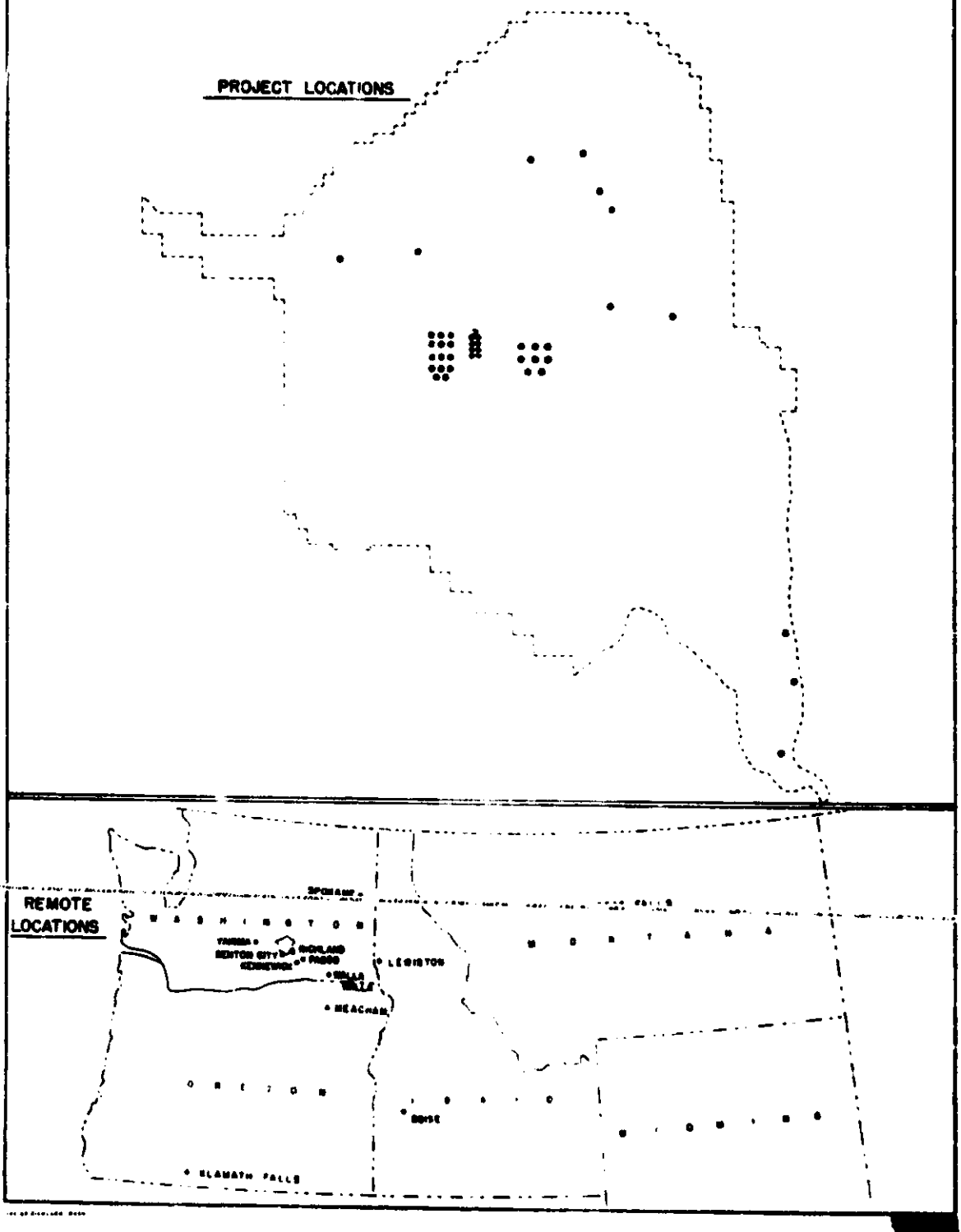
LOCATION OF AIR MONITORING STATIONS

FIGURE – 1



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per cubic meter of air. All pumps were pre-calibrated and the total air volume was based on the accumulated hours of operation as determined from running time meters installed on each motor.

The amount of radioactive contamination deposited by radioactive particles was measured by analyzing vegetation samples for the activity density of non-volatile beta particle emitters. Over 500 samples were analyzed during the period in which abnormal particulate concentrations were detected by the air monitors. Analytical methods used for these measurements and the subsequent factors applied to counting rates determined from the radiochemical analysis are detailed in related publications.[7,8]

Background and blank determinations accompanied each of the monitoring methods discussed above. Air samples collected in the room in which the filters were processed indicated a sensitivity limit of one particle per filter. The intensity sensitivity of the particle measurement was 3 disintegrations per minute for an energy spectrum with maximum energies ranging from approximately 0.16 mev to 3.5 mev. This value was determined by impregnating Dowex resin with solutions of Sr^{90}, Ru^{106}, and S^{35}, drying the resin on a piece of filter paper and exposing the particle to the radioautograph process after the counting rate was determined using standard beta counters.

Samples of vegetation collected from remote locations prior to the influx of significant particulate contamination showed the detection limit of the non-volatile beta particle emitter analysis to be 1×10^{-5} μc/g. Natural beta particle emitters such as uranium and potassium account for the activity between the counting rate detection limit of 3×10^{-6} μc/g and the actual sensitivity limit of 1×10^{-5} μc/g

RESULTS

Particle concentrations in the immediate Hanford environs during periods of normal plant operation such as September, October, and early

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November, range from 1.0×10^{-2} to 5.0×10^{-2} particle/m^3 of air.[1, 2] Results obtained from locations at the plant perimeter and at remote locations in Washington, Oregon, Idaho, and Montana normally show values on the order of 10^{-3} or 10^{-4} particle/m^3. Air filters which were removed from stations after November 11, 1952, showed significant increases in particulate contamination. Average values over weekly periods increased from the lower values previously mentioned to values ranging up to 1.7 particles/m^3 at many of the locations. Table I summarizes the results of measurements on a week-to-week basis as monitored at 4 locations near Hanford and at 7 remote locations for the period October, 1952, through January, 1953.

As indicated in Table I, the particulate contamination encountered during early November appears to be widespread throughout the Pacific Northwest. Average concentrations at locations such as Boise, Ida., Great Falls, Mont., and Lewiston, Ida., far exceeded the average concentrations measured at nearby perimeter locations such as Richland, Pasco, Kennewick, and Benton City. The tabulation also indicates that the significant concentrations were generally confined to the period between weeks ending November 14 and December 12. Average values measured during early January at all stations showed that the number of particles in the atmosphere was decreasing to the order of magnitude expected for Hanford operation.

The air filters at 3 monitoring stations in the immediate Hanford environs were processed daily during the period in which the higher concentrations prevailed. Two of these stations were inside the Separations Areas where previous data[1, 2] have indicated maximum concentrations from Hanford operation. The remaining station was at Richland. Table II summarizes the results of the day-to-day measurements at these locations for the period November 5 through December 12.

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TABLE I

RADIOACTIVE PARTICLES IN THE ATMOSPHERE

PACIFIC NORTHWEST LOCATIONS

OCTOBER 1952 - JANUARY 1953

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

Week Ending	Benton City, Wash.	Pasco Wash.	Rich-land, Wash.	Boise, Idaho	Klamath Falls, Oregon	Great Falls, Montana	Walla Walla, Wash.	Meacham, Oregon	Lewiston, Idaho	Spo-kane, Wash.	Kenne-wick, Wash.
10/ 3	1.4	0.4	3.5	10	<1.4	1.4	<1.6	<1.3	<1.5	<0.4	*
10/10	0.4	<0.4	0.4	3.9	<1.4	5.6	1.4	<1.6	<1.5	<0.4	*
10/17	5.5	<0.4	<0.4	1.7	<1.6	*	1.4	1.4	<1.5	<0.4	<0.4
10/24	<0.4	0.6	0.7	2.7	1.6	2.8	<1.4	<1.2	<1.5	<0.3	*
10/31	2.1	0.8	0.4	2.3	<1.4	1.4	1.4	1.7	<1.5	<0.4	4.2
11/ 7	12	1.4	34	0.5	4.2	1.4	2.8	1.4	<1.8	0.7	4.2
11/14	13	88	130	4.2	120	4.1	52	130	270	3.5	8.7
11/21	44	7.0	22	1750	91	380	19	47	260	40	33
11/28	58	12	40	200	59	230	27	35	70	23	4.3
12/ 5	8.4	2.8	4.5	15	41	17	41	15	23	0.8	6.2
12/12	19	4.9	23	43	1.5	34	82	21	79	42	4.9
12/19	5.3	3.9	11	42	6.5	59	4.0	3.6	13	7.7	*
12/26	2.1	1.1	1.8	9.7	1.4	99	10	3.3	3.0	0.7	0.6
1/ 2	0.7	0.7	1.1	1.2	1.4	21	1.4	4.2	1.6	1.6	0.7
1/ 9	1.8	1.0	2.1	1.6	1.2	*	1.4	8.4	1.5	*	2.0

* Unit was not operating during this period.

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TABLE II

RESULTS OBTAINED FROM DAILY PARTICLE MONITORING STUDY

HANFORD LOCATIONS

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

SAMPLING PERIOD 1952		LOCATION		
		Richland	200 East Area	200 West Area
Nov. 5	- Nov. 6	<2.5	<9.8	20
6	7	<2.2	20	9.8
7	8	<2.6	8.7	61
8	9	15	<11.2	11
9	10	48	51	110
10	11	580	1360	1560
11	12	29	8.4	42
12	13	< 9	24	<11.8
13	14	63	170	59
14	15	12	35	8.1
15	16	4.9	<11.2	< 9.8
16	17	20	<9.8	12
17	18	5.6	9.8	10
18	19	56	78	9.8
19	20	290	170	69
20	21	4.7	18	<9.0
21	22	<2.2	<10.2	<9.4
22	23	<2.6	<9.4	20
23	24	2.8	43	10
24	25	11	29	61
25	26	2.5	69	9.8
26	27	-	-	-
27	28	4.8	14	39
28	29	9.0	290	10
29	30	<2.5	670	540
30	Dec. 1	5.3	120	96
Dec. 1	2	4.2	<9.8	<9.8
2	3	<3.1	<9.8	<9.8
3	4	47	20	20
4	5	74	150	160
5	6	11	5	39
6	7	16	<12.3	41
7	8	<2.7	9.4	28
8	9	<2.4	20	20
9	10	32	29	94
10	11	2.5	<9.8	31
11	12	12	<9.4	<9.4

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The results in Table II for the period between November 5 and November 9 and for the period after December 7 may be interpreted as representative of normal Hanford operation. Maximum concentrations in excess of one particle/m^3 observed between November 10 and November 11 at the two Separations Areas stations were not necessarily influenced by any significant contribution from Hanford sources. Results from remote locations such as Lewiston, Ida., indicated values of 1.7 and 1.5 particles/m^3 on November 10 and November 11. In many instances, the results from daily monitoring at remote locations exceeded the values which were measured at the three Hanford locations. Table III summarizes the day-to-day measurements at several off-site locations.

Although the order of magnitude tends to vary considerably at individual locations indicated in Tables II and III, the trend of the data correlates favorably when comparing all locations as a group. Definite peaks appear at all locations around November 11, November 19, and December 4. Several peaks of lower magnitude which in many cases do not appear to be highly significant were observed during the middle of November. Graphs showing the trend of the day-to-day measurements at the eight locations included in Tables II and III are presented in Figures 2 through 9. Data covering the period August, 1952, through January, 1953, are included for comparison purposes.

The activity density of non-volatile beta particle emitters on vegetation showed significant increases at the same time that the air monitors showed increases in particulate contamination. Samples collected from on and off area locations after November 10 showed increases in this activity from values on the order of 2×10^{-5} or 3×10^{-5} $\mu c/g$ to values on the order of 1×10^{-4} $\mu c/g$ to 5×10^{-4} $\mu c/g$. In general, the vegetation sampling program was not extended as far from the plant as the air monitoring program during this period; the bulk of the measurements represented locations within a radius of 200 miles of the Hanford operation.

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TABLE III

RESULTS OBTAINED FROM DAILY PARTICLE MONITORING STUDY OFF AREA LOCATIONS

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

SAMPLING PERIOD 1952	LOCATION				
	Klamath Falls, Oregon	Spokane, Wash.	Lewiston, Idaho	Walla Walla, Wash.	Benton City, Wash.
Nov. 5 - Nov. 6	20	2.9	25	10	< 3.1
6 - 7	<11	2.6	<11	< 9.8	2.0
7 - 8	12	3.7	**	<10	8.4
8 - 9	< 9.2	2.9	< 5.6	< 9.4	7.4
9 - 10	9.4	12	13	7.6	71
10 - 11	760	*	1720	310	200
11 - 12	430	130	1450	130	21
12 - 13	71	< 2.0	59	16	7.7
13 - 14	41	29	190	49	74
14 - 15	< 8.4	2.1	9.8	< 9.8	5.1
15 - 16	<12	< 2.5	<10	10	< 2.6
16 - 17	< 9.9	2.5	< 9.8	< 8.4	2.4
17 - 18	20	61	< 9.8	45	24
18 - 19	42	20	29	*	12
19 - 20	250	29	360	230	320
20 - 21	27	25	18	11	< 2.3
21 - 22	19	13	12	7.8	2.4
22 - 23	<11	*	9.8	<11	< 2.7
23 - 24	38	4.9	<33	<11	7.1
24 - 25	82	**	<11	<10	13
25 - 26	20	**	20	*	9.8
26 - 27	81	**	31	*	*
27 - 28	96	**	<39	7.2	11
28 - 29	51	4.9	<12	< 7.4	< 2.4
29 - 30	7.6	< 2.5	11	17	2.5
30 - Dec. 1	20	< 2.5	31	19	11
1 - 2	12	< 2.5	45	11	2.8
2 - 3	< 8.7	2.8	56	*	2.0
3 - 4	<11	39	150	110	19
4 - 5	<10	250	240	430	82
5 - 6	< 9.8	42	*	96	15
6 - 7	<23	28	*	43	15

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TABLE III (contd.)

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

SAMPLING PERIOD 1952	LOCATION				
	Klamath Falls, Oregon	Spokane, Wash.	Lewiston, Idaho	Walla Walla, Wash.	Benton City, Wash.
Dec. 7 - Dec. 8	< 7.8	< 3.1	32	9.0	2.0
8 9	13	4.2	< 9.8	10	3.1
9 10	< 11	6.9	49	11	12
10 11	*	2.5	9.8	14	15
11 12	10	4.2	20	12	4.7
12 13	< 7.1	4.2	< 10	**	**
13 14	9.8	< 2.5	10	**	**
14 15	9.0	13	< 11	**	**

* These filters were exposed for 48 or 72 hour periods.
** Samples were not obtained during this period.

The maximum activity density of non-volatile beta particle emitters on vegetation observed near the 200 West Area was 1.9×10^{-3} μc/g. This sample was collected at the same location where the air filter monitoring program showed the highest air-borne concentration in the immediate environs (1.6 particle/m^3 on November 10). Samples collected from many off-site locations showed values on the order of 10^{-4} μc/g with a predominance of higher values occurring near Yakima, Wash., Lewiston, Ida., and Moxee City, Wash. The Lewiston measurements showed favorable agreement with the air monitoring results from this location. Comparable to the air monitoring results, the activity density from non-volatile beta particle emitters on vegetation was decreasing to normal values toward the latter part of December. Detailed summaries showing average and maximum values measured for the activity density of non-volatile emitters on vegetation samples collected during the last three months of 1952 ay be referred to in a related publication.(9)

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Regional Survey

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FIGURE – 2

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
RICHLAND, WASHINGTON

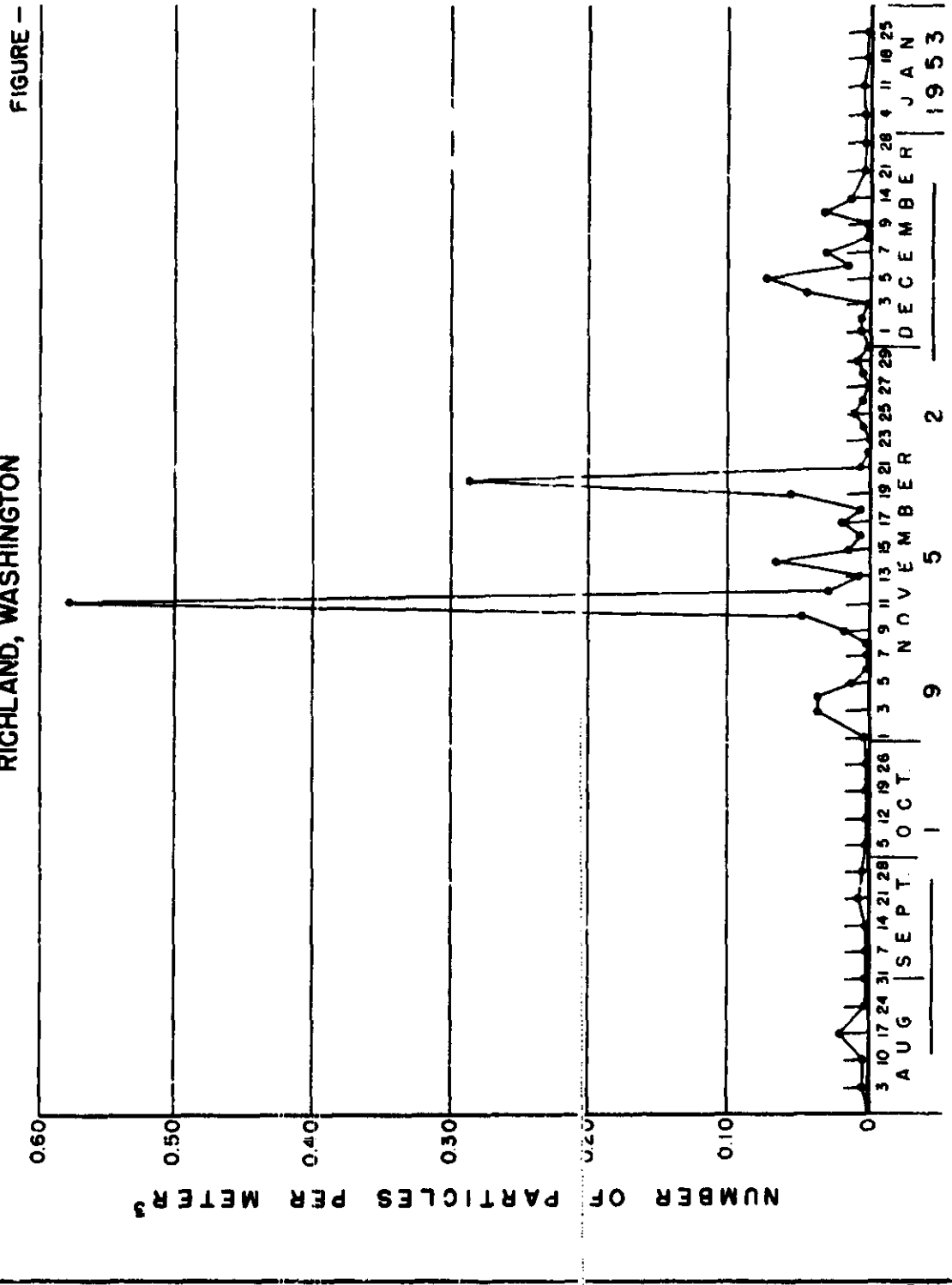

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FIGURE - 3

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
HANFORD WORKS -- 200 WEST AREA

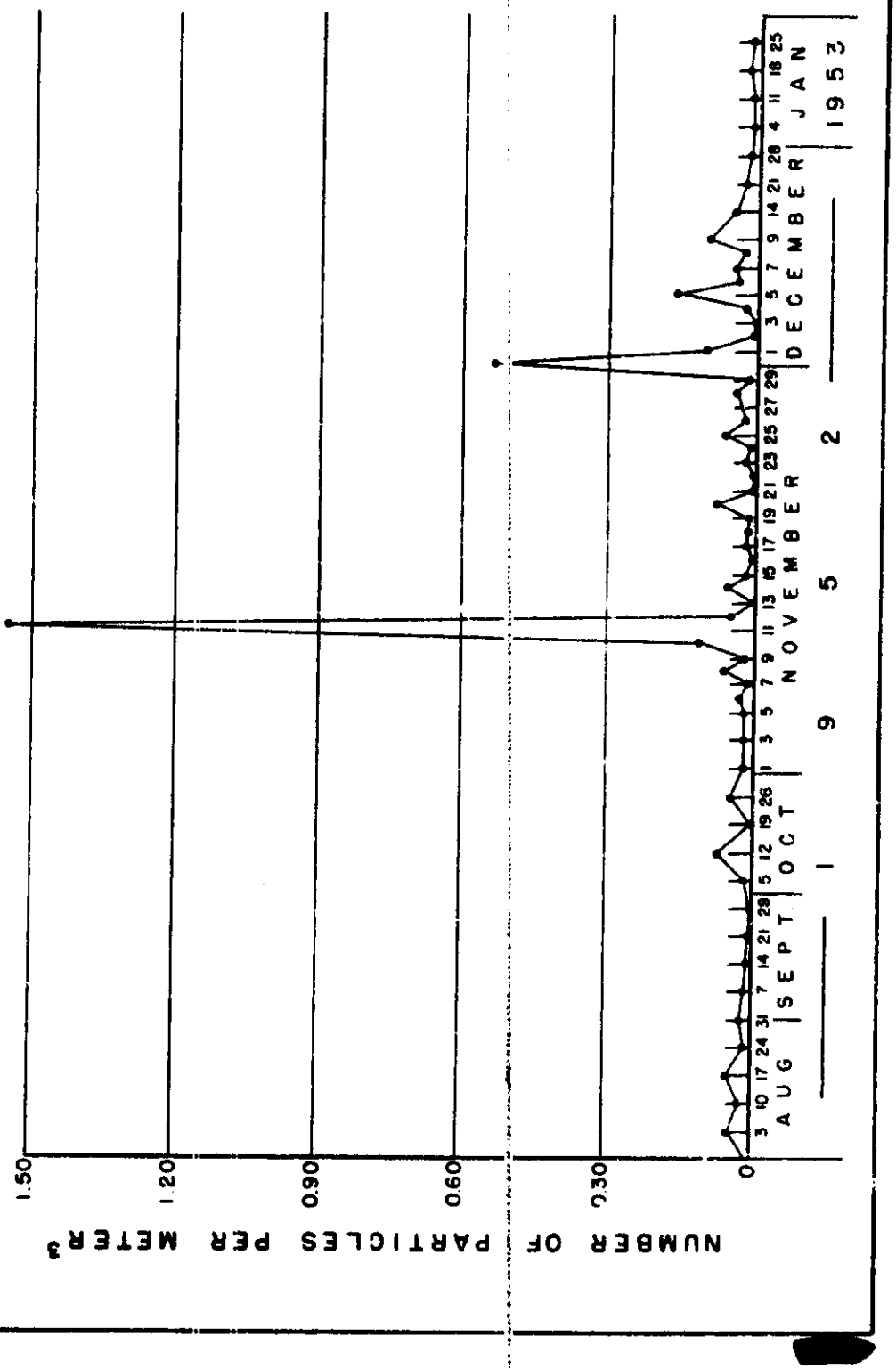

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FIGURE – 4

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
HANFORD WORKS – 200 EAST AREA

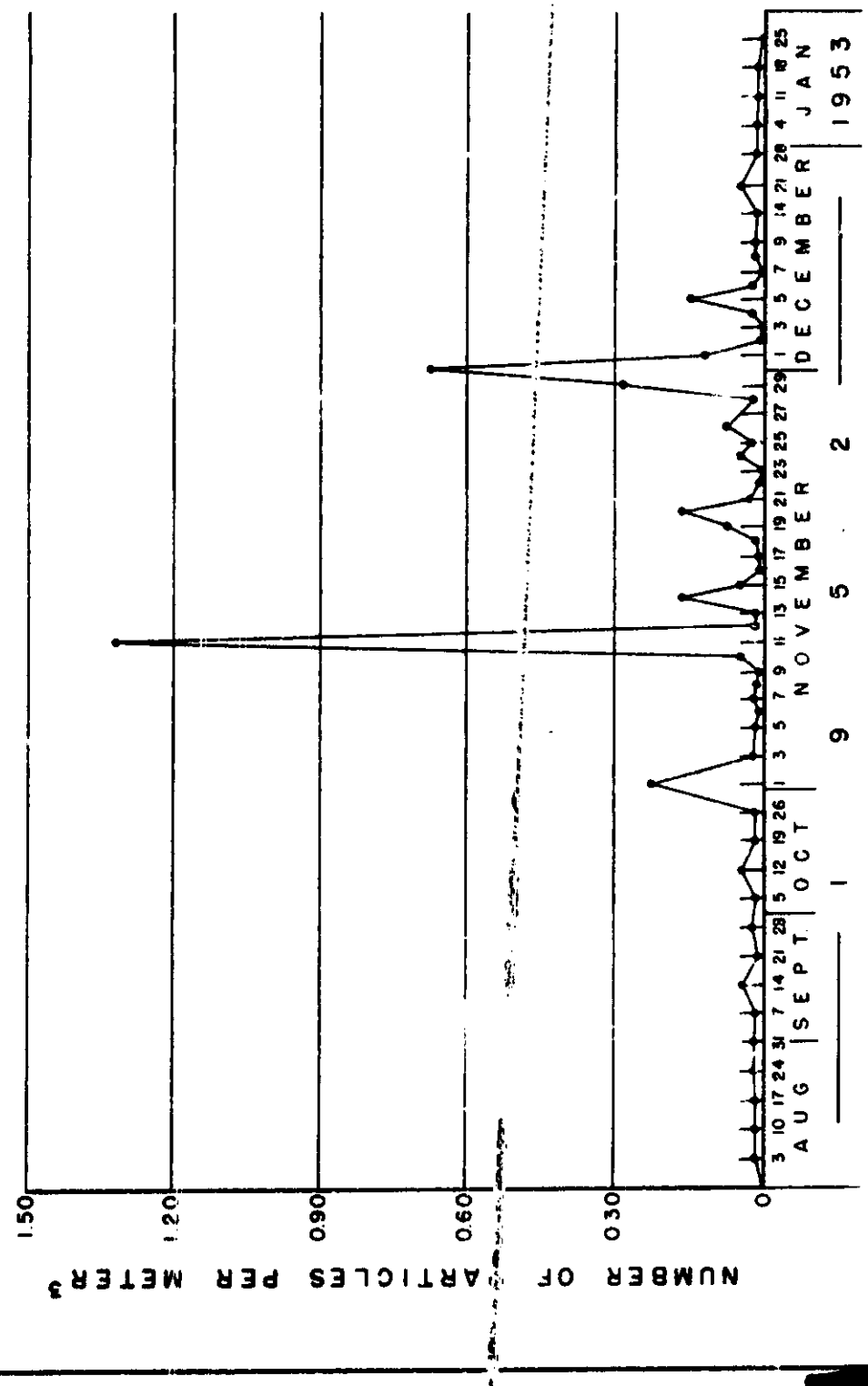

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FIGURE — 5

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
BENTON CITY, WASHINGTON

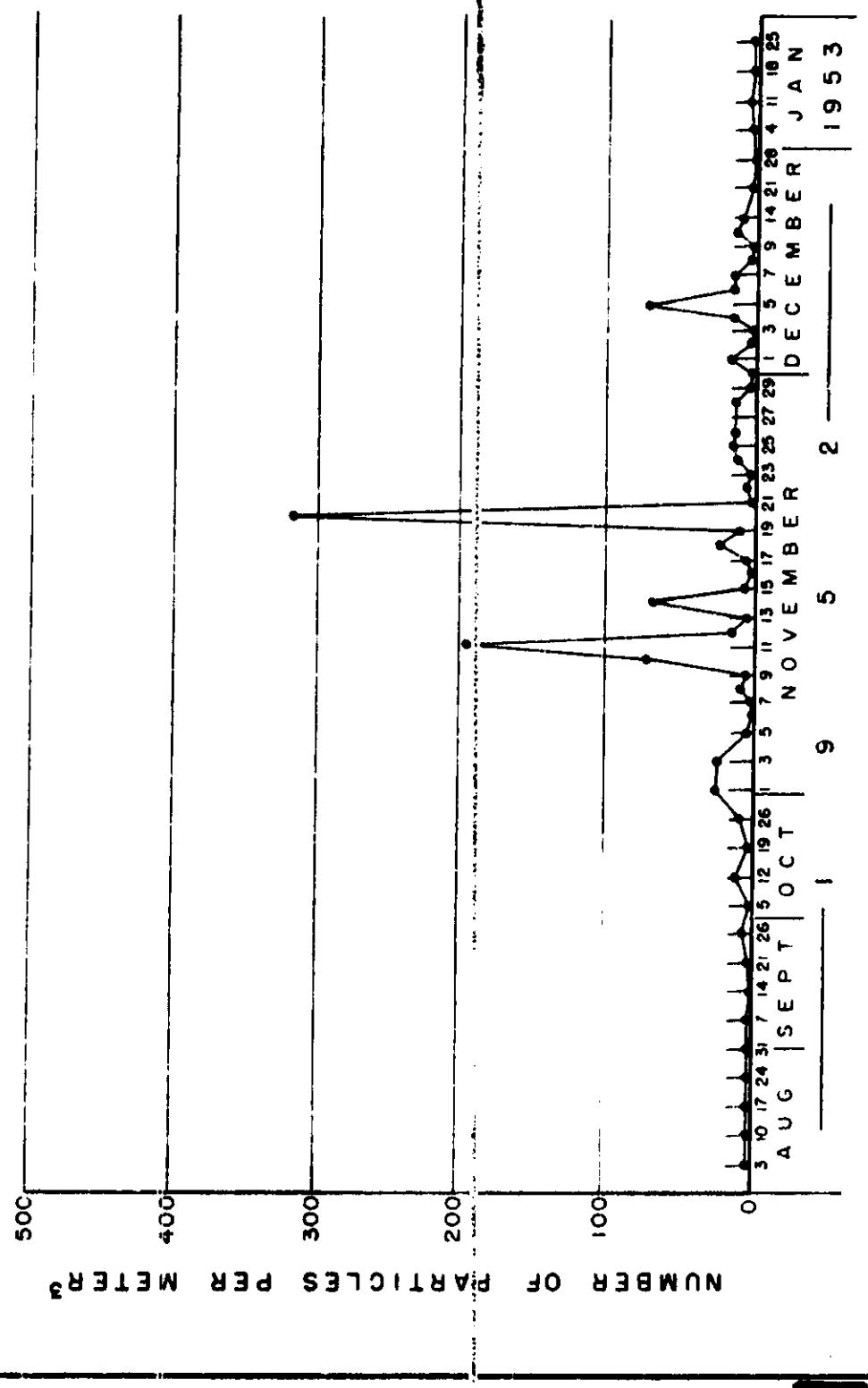

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FIGURE – 6

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
WALLA WALLA, WASHINGTON

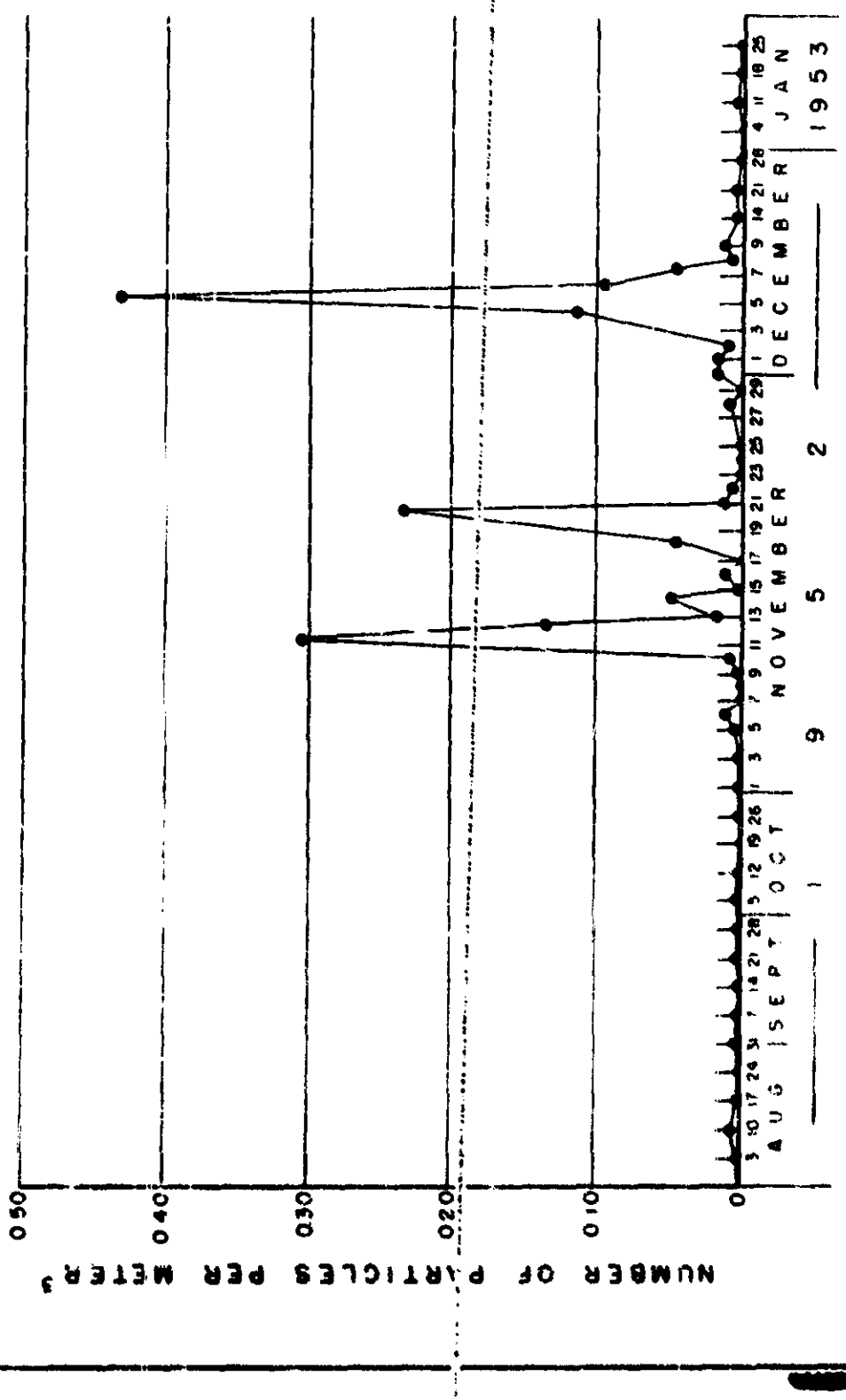

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FIGURE - 7

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
SPOKANE, WASHINGTON

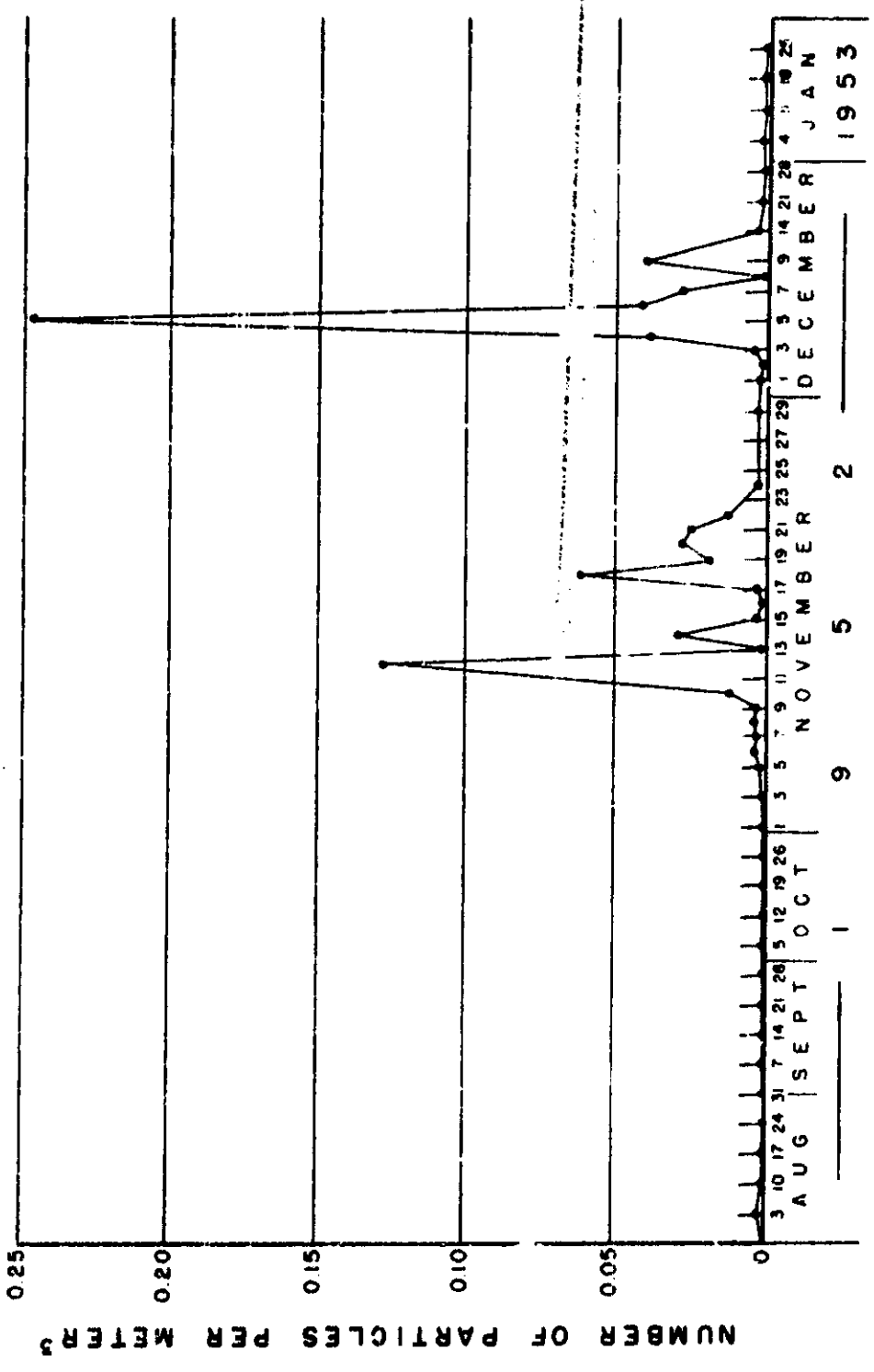

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FIGURE – 6

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
LEWISTON, IDAHO

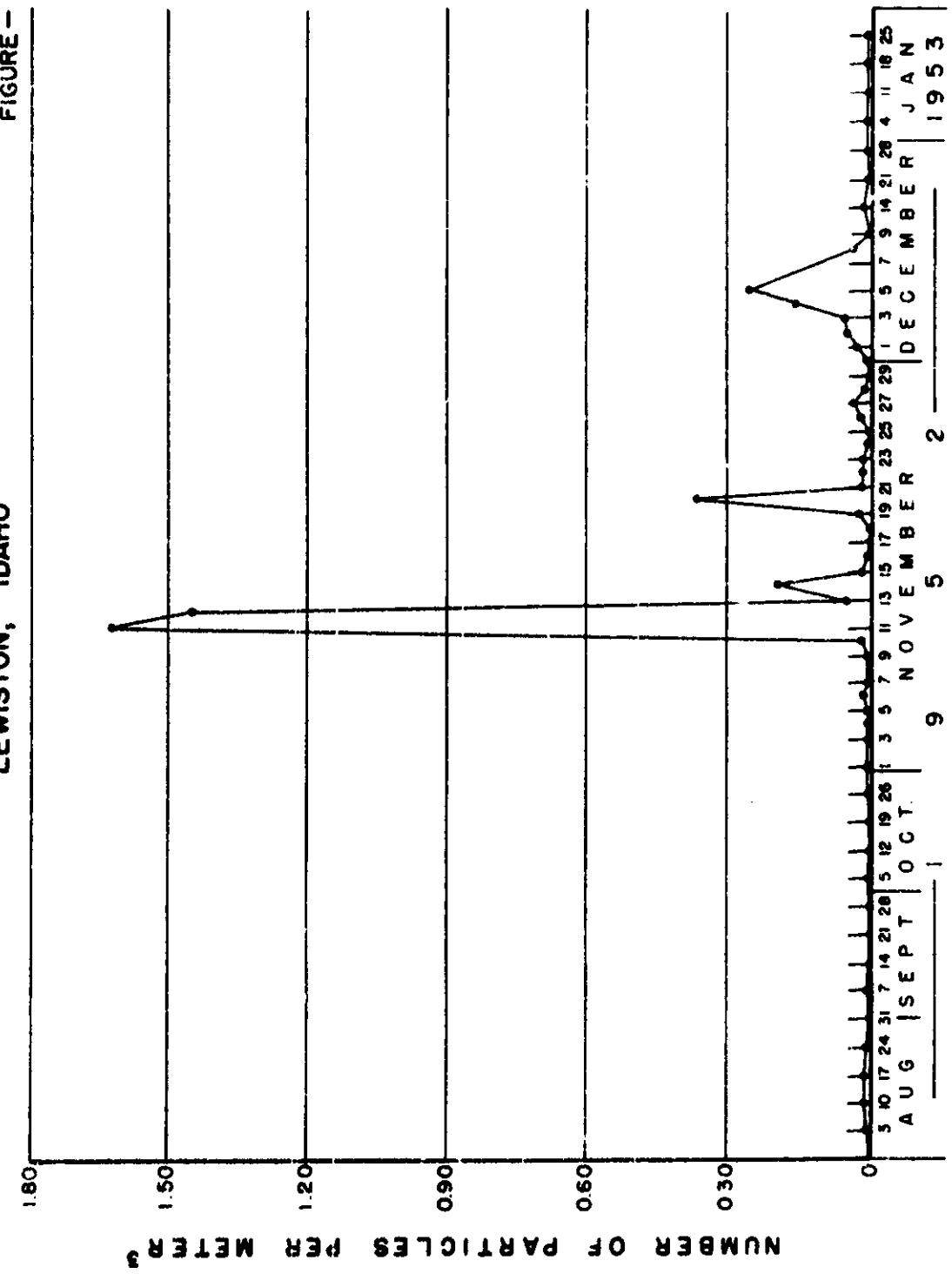

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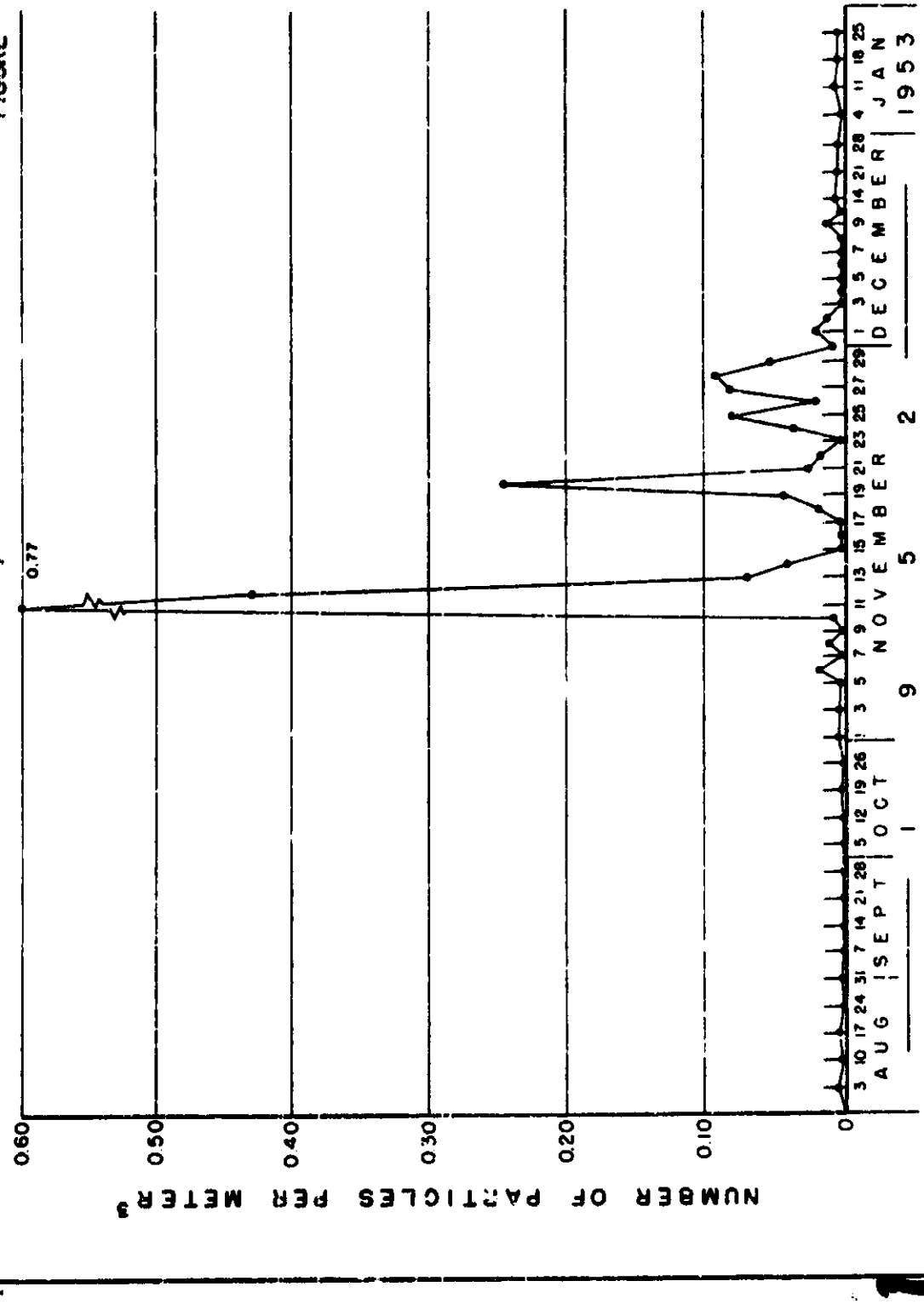
FIGURE - 9

RADIOACTIVE PARTICLES MEASURED
IN THE ATMOSPHERE AT
KLAMATH FALLS, OREGON



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