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Filter Pack Technique for Classifying Radioactive Aerosols by Particle Size

Part 5 - Final Report

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PREVIOUS REPORTS IN THIS SERIES

"Part 1—Preliminary Report and Evaluation," L. B. Lockhart, Jr., and R. L. Patterson, Jr., NRL Report 5970, Aug. 16, 1963

"Part 2—Isotopic Fractionation with Particle Size," L. B. Lockhart, Jr., R. L. Patterson, Jr., and A. W. Saunders, Jr., NRL Report 6164, Oct. 28, 1964

"Part 3—The Size Distribution of Airborne Fission Products During 1963 and 1964," L. B. Lockhart, Jr., R. L. Patterson, Jr., and A. W. Saunders, Jr., NRL Report 6305, July 29, 1965

"Part 4—Mathematical Considerations," R. M. Mason, P. C. Ryan, and S. L. Hill, NRL Report 6306, Aug. 9, 1965

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ABSTRACT

During the past several years, a number of collections of radioactive aerosols in the atmosphere have been made on packs of filters, of different characteristics, through which an air stream passes sequentially. The radioactivity distribution on the filters has been related to the sizes of the particulate matter in the atmosphere with which the radioactivity was associated.

Conditions have been developed for obtaining size distributions in 3 or 4 size groups, in the submicron range, through use of packs consisting of 3 or 4 well-characterized filter media operated in two convenient air flow regimes, 60-70 cm/sec and 145 cm/sec. Simple two-filter packs can be employed to monitor the behavior of particulate matter in a restricted size range (e.g., either the $>1.0\,\mu$-diameter component or the $<0.3\mu$-diameter component). The general method is applicable to the sizing of any aerosol material for which suitable analytical techniques are available.

Gross β activity levels and concentrations of specific radionuclides in the atmosphere at Washington, D.C., have been documented for the period January 1965 through July 1966.

PROBLEM STATUS

This is the final report on this problem. Unless otherwise notified this problem will be considered closed 30 days after the issuance of this report.

AUTHORIZATION

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FILTER PACK TECHNIQUE FOR CLASSIFYING RADIOACTIVE AEROSOLS BY PARTICLE SIZE

PART 5 -- FINAL REPORT

INTRODUCTION

Since 1963, routine collections of airborne fission products have been made utilizing packs of 3 or 4 superimposed filters to obtain information on the radioactivity distribution with particle size (1-3). These studies have suggested that the small stratospheric particles of high specific activity agglomerate with larger, inactive, tropospheric aerosols, and that the size distribution varies temporally, probably as a function of meteorological conditions and residence time of the radioactivity in the troposphere. Little fractionation of one radionuclide relative to another has been observed during this settling process; however, fresh debris did show quite a different size distribution than the older debris from the stratosphere, with a general tendency toward association of fresh radioactivity with larger particles (3).

The relative amounts of radioactivity retained on the various filters in a 4-filter-pack collection were interpreted, in terms of the relative quantities of radioactivity associated with particles in 4 size groupings, through use of a matrix of 4 simultaneous linear equations whose coefficients were dependent on the retention efficiencies of the filters (3,4). Since filter efficiency is a function of both particle size and air velocity through the filter, the derived solution set was applicable to a unique sampling condition. For more general application of the method, it was desired that similar equations be derived for other flow conditions; moreover, it was considered that in many cases the use of simpler filter packs (2 or 3 filters) would be of greater practicability.

The present report deals principally with this latter aspect, namely, the development of suitable equations for interpreting the results of filter pack collections in terms of a smaller number of size distributions and the development of a set of equations covering a lower rate of air flow. A second phase of the problem covers the observations made on fission product concentrations and on the size distributions of airborne radioactive particulate matter in the air at Washington, D.C., during the period January 1965 through June 1966.

EXPERIMENTAL PROCEDURES AND RESULTS

Collections of airborne radioactivity were made, as described previously (1-3), on packs of 3 or 4 superimposed, 4-inch-diameter filters of increasing retentivity through which the sampled air passed sequentially. The filters were arranged as follows:

Filter position	3-filter pack	4-filter pack
Initial	IPC 1478	IPC 1478
Second	Type 5G	IPC 1478
Third	—	Type 5G
Final	Type 6	Type 6

Comparable results were obtained when a glass-fiber filter of high retentivity (Gelman A or Whatman GF/A) was used as the final filter.

Collections intended for the determination of the size distribution of the long-lived gross β activity in the air were generally of 3 to 4 days duration; for the collection of short-lived radon daughter products, a 30-min collection period was employed. Flow rates (linear velocities) varied from about 60 cm/sec to about 175 cm/sec, depending on the particular sampling unit employed. The change in flow rate never exceeded 10 percent during any collection; hence, the quantity of collected dust was not sufficient to affect measurably the retention characteristics of the filters (see Appendix A).

The total long-lived radioactivity collected on these filter packs is a measure of the average fission-product concentration in the ground level air during the exposure time. This information has been summarized in Table 1; other collections made during this same period, but under different flow conditions, confirmed the reported fission-product levels as well as the indicated variations in size distribution with time. During this period of rather low atmospheric concentrations of nuclear bomb debris, low sample-counting rates and a rather high counter background (ca. 30 counts/min) reduced the accuracy of the measurements of the radioactivity distribution among the filters to such a degree that no size assignments were attempted. The changes in the concentrations of gross β activity and of some individual long-lived β-emitters in the atmosphere during the period January 1965 through July 1966 are shown in Fig. 1. A seasonal effect, with a maximum in the spring of the year, is superimposed on a continuing downward trend in fission product activity levels which began in mid-1963 following the termination of large-scale nuclear testing in late 1962. Though it is not apparent from this figure, fresh nuclear debris from the Communist Chinese tests held at Lop Nor were present on several occasions; this is indicated by increases in gross β activity encountered in several of the collections made in late May and June 1966 (Table 1) and, as indicated below, by the presence of short-lived radionuclides in several collections subjected to radiochemical analysis.

Concurrently with the above collections, for one month each quarter large collections were made on 3-filter packs (IPC 1478/Type 5G/Whatman GF/A filters; air velocity 61 cm/sec) and subjected to radiochemical analysis to determine the extent of isotopic fractionation with particle size. Data for the 1965 and 1966 collections are summarized in Table 2. The presence of some shorter-lived fission products (Sr^{89}, Y^{91}) during February and May 1965 is attributable to nuclear tests carried out in mainland China on October 16, 1964, and May 14, 1965, respectively; the Ce^{141}, Sr^{89} and Y^{91} present in the May 1966 collection originated in the 3rd Chinese test, held on May 9, 1966.

The radiochemical analyses do not indicate any systematic fractionation of the long-lived fission-product radionuclides relative to one another; however, there is observed during this period, as in past years, a considerable fluctuation in the Cs^{137}/Sr^{90} activity ratios among the various collections and among the filters of a given collection. While this variability within any one collection could presumably be due to migration of activity among the filters as a result of dissolution in condensed moisture, there is no indication of movement of Sr^{90} or Cs^{137} to the bottom filter, where an excess of either would be readily detected; moreover, the month-to-month variation must be due to fractionation which occurred prior to capture by the filter. The shorter-lived radionuclides (Ce^{141}, Sr^{89}, Y^{91}), indicative of fresh nuclear debris, exhibit here, as in prior studies, a different distribution with particle size: Sr^{89} is biased toward a smaller-than-average particle size, while Y^{91} and Ce^{141} have a larger proportion of activity in both the larger and smaller size fractions at the expense of the 0.3-1.0μ group.

The natural Pb^{210}, both in its seasonal behavior and its size distribution, is markedly different from the fission products with a much higher proportion associated with smaller particles.

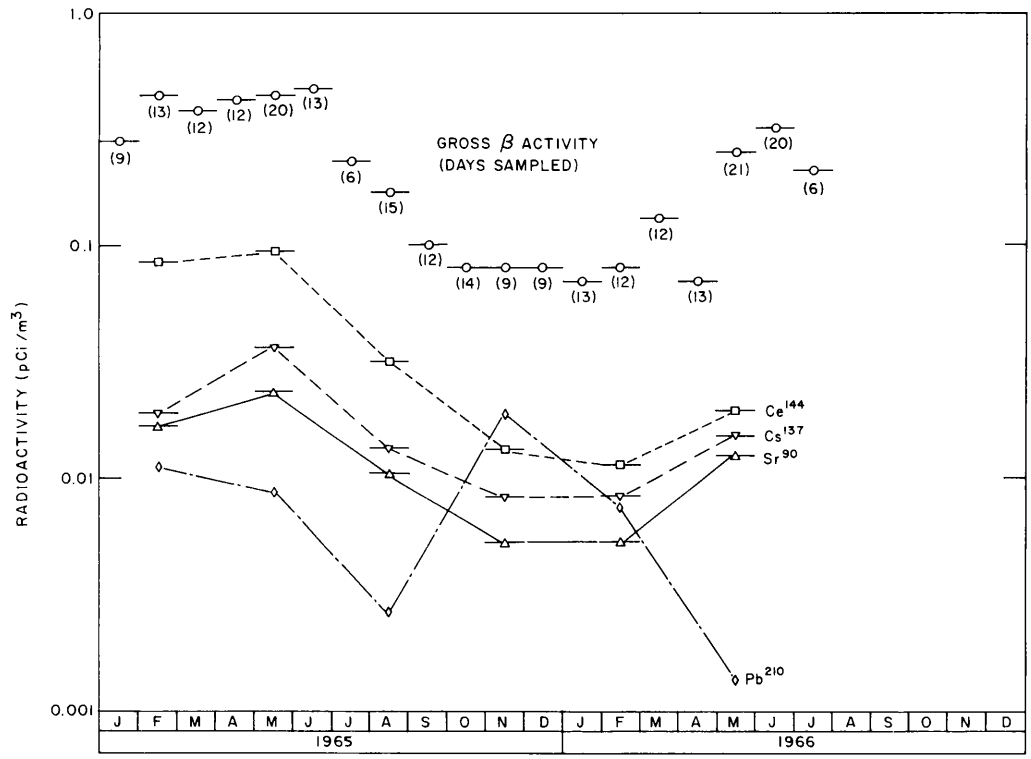

Fig. 1 - Concentrations of selected radionuclides in the air at Washington, D.C., January 1965–July 1966

MATHEMATICAL CONSIDERATIONS

The set of simultaneous linear equations devised for interpreting the data from the standard pack of 4 filters operated at a linear velocity of 145 cm/sec is as follows (3,4):

$$\left.\begin{aligned} A_1 &= 95.00\,x_1 + 30.00\,x_2 + 10.00\,x_3 + 2.00\,x_4 \\ A_2 &= 4.75\,x_1 + 21.00\,x_2 + 9.00\,x_3 + 1.96\,x_4 \\ A_3 &= 0.25\,x_1 + 48.80\,x_2 + 77.80\,x_3 + 38.00\,x_4 \\ A_4 &= 0.00\,x_1 + 0.20\,x_2 + 3.20\,x_3 + 58.04\,x_4 \end{aligned}\right\} \qquad (1)$$

where A_1, A_2, A_3, and A_4 are the measured activity distributions (in percent of the total) on the 4 filters, and x_1, x_2, x_3, and x_4 are the relative amounts of radioactivity associated with particles in the 4 size groupings, from largest to smallest size. It should be noted that this set of equations (system (1)) is not unique; moreover, it will give meaningful results only when the distribution of radioactivity within the subgroups (x's) remains unchanged.

In view of the limitation on interpreting the radioactivity distributions in terms of absolute size distributions, it was thought advisable that this method be employed in a mode where less detailed information would be extracted from the measurements. Consequently, by treating filters 2 and 3 as a single filter and dividing the activity into 3 rather than 4 groups, the following set of equations resulted:

Table 1
Filter Pack Collections of Airborne Fission Products at Washington, D.C., 1965-1966

Collection Date	Time (hr)	Precipitation (in.)	Air Flow*		Volume (m^3)	Gross β Activity		Radioactivity Distribution (in percent of total)			
			(cfm)	(cm/sec)		(counts/min)†	(pCi/m^3)	IPC (1)	IPC (2)	Type 5G (3)	Type 6 (4)‡
1965											
Jan. 8-11	65.5	1.14 (s)	18.4	145	2048	57.0 ± 0.7	0.35	54.2 ± 1.0	11.8 ± 0.6	30.2 ± 0.8	3.8 ± 0.5
Jan. 15-18	63.5	0.24 (s)	18.85	149	2035	47.2 ± 0.8	0.29	64.6 ± 1.6	7.0 ± 0.7	26.3 ± 1.0	2.1 ± 0.6
Jan. 22-25	63.5	0.72	19.0	150	2050	25.0 ± 0.5	0.15	52.0 ± 1.9	10.8 ± 1.2	32.4 ± 1.7	4.8 ± 1.2
Jan. 29-Feb. 1	63.5	0.12 (s)	18.8	149	2030	54.8 ± 0.7	0.34	63.5 ± 1.1	7.9 ± 0.6	27.0 ± 0.8	1.6 ± 0.6
Feb. 5-8	65	1.20	22.5	167	2487	83.4 ± 0.8	0.42	60.0 ± 0.8	11.1 ± 0.4	27.8 ± 0.6	1.1 ± 0.4
Feb. 12-15	64.5	0.15 (s)	18.85	149	2067	44.0 ± 0.7	0.27	55.5 ± 1.3	10.2 ± 0.7	33.0 ± 1.1	1.3 ± 0.7
Feb. 19-23	88	trace (s)	19.15	151	2864	112.9 ± 0.8	0.50	56.6 ± 0.6	9.9 ± 0.3	31.7 ± 0.5	1.8 ± 0.3
Feb. 26-Mar. 1	64.5	0.0	19.15	151	2100	89.5 ± 0.8	0.54	57.8 ± 0.8	10.1 ± 0.4	29.9 ± 0.5	2.2 ± 0.3
Mar. 5-8	63.5	0.06	19.0	150	2051	22.0 ± 0.7	0.14	51.4 ± 2.5	12.3 ± 1.4	34.1 ± 2.1	2.2 ± 1.4
Mar. 12-15	63.5	trace	19.4	153	2094	69.9 ± 0.8	0.42	63.7 ± 1.0	9.3 ± 0.4	26.0 ± 0.7	1.0 ± 0.4
Mar. 19-22	65.5	0.40	19.8	156	2205	85.5 ± 0.8	0.49	59.1 ± 0.8	11.6 ± 0.4	28.3 ± 0.5	1.0 ± 0.4
Mar. 26-29	64	0.32	18.6	147	2023	71.2 ± 0.8	0.45	62.4 ± 0.9	11.0 ± 0.4	24.9 ± 0.6	1.7 ± 0.4
Apr. 2-5	64	trace	18.75	148	2040	106.3 ± 0.8	0.66	56.1 ± 0.6	12.7 ± 0.3	30.5 ± 0.4	0.7 ± 0.3
Apr. 9-12	64	trace	19.0	149	2067	31.3 ± 0.8	0.19	59.8 ± 1.9	12.1 ± 1.0	25.6 ± 1.0	2.5 ± 1.0
Apr. 16-19	65.3	0.10	18.95	149	2103	37.7 ± 0.7	0.23	54.4 ± 1.5	10.6 ± 0.8	33.2 ± 1.2	1.8 ± 0.8
Apr. 23-26	65	0.31	19.0	149	2099	96.5 ± 0.9	0.58	71.6 ± 0.9	9.5 ± 0.3	18.3 ± 0.5	0.6 ± 0.3
Apr. 30-May 3	65	0.02	18.7	147	2066	87.2 ± 0.8	0.53	59.3 ± 0.8	11.1 ± 0.4	28.7 ± 0.5	0.9 ± 0.4
May 14-17	65	0.27	18.6	141	2055	85.0 ± 0.7	0.52	55.8 ± 0.7	12.9 ± 0.4	30.6 ± 0.5	0.7 ± 0.4
May 17-19	51	0.0	19.05	145	1652	22.2 ± 0.7	0.17	55.4 ± 2.5	14.0 ± 1.4	29.3 ± 1.6	1.3 ± 1.4
May 19-21	52	0.0	19.4	147	1715	38.5 ± 0.7	0.28	54.6 ± 1.4	11.4 ± 0.8	32.5 ± 1.2	1.5 ± 0.8
May 21-24	64.5	trace	19.0	144	2083	65.2 ± 0.8	0.40	61.2 ± 1.1	10.4 ± 0.5	26.2 ± 0.7	2.2 ± 0.5
May 24-26	53.5	trace	19.5	148	1773	73.4 ± 0.9	0.52	62.3 ± 1.1	12.3 ± 0.7	22.5 ± 0.5	2.9 ± 0.4
May 26-28	49	0.28	19.45	148	1620	79.6 ± 0.8	0.62	52.3 ± 0.8	9.1 ± 0.4	34.6 ± 0.6	4.0 ± 0.4
May 28-30	70	0.95	18.95	144	2256	79.5 ± 0.7	0.45	58.0 ± 0.7	12.2 ± 0.4	28.9 ± 0.6	0.9 ± 0.4
May 31-June 1	51	0.0	19.2	146	1664	81.2 ± 0.7	0.62	56.7 ± 0.7	13.1 ± 0.4	28.8 ± 0.6	1.4 ± 0.4
June 3-7	90	0.0	19.75	150	3021	79.2 ± 0.7	0.33	62.9 ± 0.8	9.5 ± 0.4	26.8 ± 0.6	0.8 ± 0.4
June 7-9	53	0.01	19.2	146	1729	50.2 ± 0.7	0.37	52.2 ± 1.1	9.4 ± 0.6	36.5 ± 1.0	1.9 ± 0.6
June 9-11	48	0.22	18.6	141	1518	37.3 ± 0.7	0.31	52.3 ± 1.5	10.7 ± 0.8	35.7 ± 1.3	1.3 ± 0.8
June 18-21	65	0.06	21.35	162	2358	136.0 ± 0.8	0.73	58.8 ± 0.5	11.3 ± 0.2	28.0 ± 0.3	1.9 ± 0.2
July 9-12	66.5	0.99	21.0	159	2373	33.5 ± 0.7	0.18	56.1 ± 1.6	11.0 ± 0.9	28.1 ± 1.3	4.8 ± 0.9
July 16-19	67	1.45	20.1	153	2288	49.6 ± 0.7	0.27	48.6 ± 1.0	15.5 ± 0.6	25.8 ± 0.9	10.1 ± 0.6
July 30-Aug. 2	65	1.34	25.9	197	2861	29.2 ± 0.6	0.13	—	—	—	—
Aug. 6-9	67.5	0.20	25.85	196	2965	41.8 ± 0.6	0.18	—	—	—	—
Aug. 13-16	66	trace	22.9	174	2569	58.2 ± 0.7	0.29	64.8 ± 1.0	9.5 ± 0.5	23.4 ± 0.7	2.3 ± 0.5
Aug. 20-23	65	0.69	22.95	175	2535	27.0 ± 0.6	0.13	69.3 ± 2.1	9.2 ± 1.1	18.9 ± 1.2	2.6 ± 1.1
Aug. 27-30	67	0.29	23.2	176	2642	26.7 ± 0.6	0.13	58.4 ± 2.0	13.5 ± 1.1	25.8 ± 1.2	2.3 ± 1.1
Sept. 3-7	96	0.0	23.0	175	3754	29.6 ± 0.6	0.10	61.8 ± 1.9	9.8 ± 1.0	25.6 ± 1.1	2.7 ± 1.0
Sept. 10-13	64	1.64	23.1	176	2513	19.0 ± 0.6	0.10	59.0 ± 2.7	11.6 ± 1.6	24.7 ± 1.8	4.7 ± 1.6
Sept. 17-20	64	0.0	22.9	174	2491	14.6 ± 0.6	0.07	48.0 ± 2.8	13.0 ± 2.1	32.9 ± 2.3	6.1 ± 2.1
Sept. 28-30	55	0.0	23.0	175	2151	24.9 ± 0.6	0.15	65.8 ± 2.2	11.6 ± 1.2	21.3 ± 1.3	1.2 ± 1.2
Oct. 5-7	42	trace	23.15	176	1653	11.9 ± 0.6	0.09	59.6 ± 4.3	7.6 ± 2.6	27.8 ± 2.8	5.0 ± 2.6
Oct. 8-11	65.5	0.12	22.6	172	2516	10.1 ± 0.6	0.05	60.5 ± 4.5	8.9 ± 3.0	23.8 ± 3.2	6.8 ± 3.0
Oct. 15-18	68	0.0	22.5	171	2601	20.2 ± 0.6	0.10	58.5 ± 2.6	8.9 ± 1.6	28.2 ± 1.7	4.4 ± 1.6
Oct. 25-28	73	0.0	22.7	172	2817	14.3 ± 0.6	0.06	58.0 ± 3.6	4.9 ± 2.1	30.8 ± 2.3	6.3 ± 2.1

Table 1 continues

Table 1 (continued)

Collection Date	Time (hr)	Precipitation (in.)	Air Flow*		Volume (m^3)	Gross β Activity		Radioactivity Distribution (in percent of total)			
			(cfm)	(cm/sec)		(count/min)†	(pCi/m^3)	IPC (1)	IPC (2)	Type 5G (3)	Type 6 (4)‡
Oct. 29-Nov. 1	66	0.0	22.7	172	2547	17.4 ± 0.6	0.09	54.6 ± 3.0	9.7 ± 1.8	31.1 ± 2.0	4.6 ± 1.8
Nov. 5-8	66	0.0	22.7	172	2547	17.1 ± 0.6	0.09	56.7 ± 3.0	8.8 ± 1.8	29.2 ± 2.0	5.3 ± 1.8
Nov. 12-15	70	0.02	22.9	174	2725	17.8 ± 0.6	0.08	50.6 ± 2.3	9.5 ± 1.7	33.2 ± 2.0	6.7 ± 1.7
Nov. 23-26	71	0.0	22.8	173	2751	17.9 ± 0.6	0.08	47.5 ± 2.3	9.5 ± 1.7	36.3 ± 2.0	6.7 ± 1.7
Nov. 29-Dec. 2	66	0.0	22.9	174	2569	8.8 ± 0.6	0.04	42.1 ± 4.2	13.6 ± 3.5	37.5 ± 4.1	6.8 ± 3.5
Dec. 3-6	65	trace	20.6	156	2276	18.1 ± 0.6	0.10	56.3 ± 2.4	8.8 ± 1.7	29.3 ± 1.9	5.6 ± 1.7
Dec. 13-16	64	trace	20.25	154	2203	14.4 ± 0.6	0.08	53.5 ± 3.0	10.4 ± 2.1	31.3 ± 2.4	4.8 ± 2.1
1966											
Jan. 7-10	65	trace	17.0	129	1878	13.1 ± 0.6	0.09	55.7 ± 3.3	9.2 ± 2.4	27.5 ± 2.6	7.6 ± 2.4
Jan. 14-17	64	0.0	17.3	131	1882	10.9 ± 0.6	0.07	56.9 ± 4.0	8.3 ± 2.7	33.0 ± 3.3	1.8 ± 2.8
Jan. 21-24	63.5	0.67	17.4	132	1877	5.7 ± 0.6	0.04	70.1 ± 8.2	0.0 ± 5.3	26.3 ± 5.8	3.6 ± 5.6
Jan. 28-Feb. 1	88	1.09 (s)	17.5	133	2618	17.8 ± 0.6	0.09	53.4 ± 2.4	5.1 ± 1.7	35.9 ± 2.1	5.6 ± 1.8
Feb. 4-7	64	trace	17.6	134	1914	12.7 ± 0.6	0.08	46.5 ± 3.1	7.1 ± 2.4	37.1 ± 2.9	9.3 ± 2.5
Feb. 11-14	64	1.28	17.4	132	1892	6.6 ± 0.6	0.04	59.1 ± 6.6	1.5 ± 4.6	31.8 ± 5.2	7.6 ± 4.9
Feb. 18-21	68.5	trace	17.4	132	2025	20.2 ± 0.6	0.13	60.9 ± 2.6	5.9 ± 1.6	31.7 ± 1.8	1.5 ± 1.6
Feb. 25-28	63.5	trace	17.8	135	1921	11.0 ± 0.6	0.07	64.6 ± 4.3	8.2 ± 2.7	25.5 ± 2.9	1.7 ± 2.8
Mar. 4-7	64.5	0.25	17.9	136	1962	16.6 ± 0.6	0.11	56.0 ± 2.7	9.0 ± 1.9	30.1 ± 2.1	4.9 ± 1.9
Mar. 11-14	64	0.12	17.2	131	1870	23.7 ± 0.6	0.16	58.6 ± 2.2	10.2 ± 1.4	27.0 ± 1.5	4.2 ± 1.4
Mar. 18-21	72	0.02	17.3	131	2117	19.4 ± 0.6	0.12	57.8 ± 2.6	5.7 ± 1.6	32.0 ± 1.8	4.5 ± 1.6
Mar. 25-28	65	trace	17.1	130	1890	20.7 ± 0.6	0.14	57.0 ± 2.2	12.1 ± 1.6	28.0 ± 1.7	2.9 ± 1.5
Apr. 1-4	65	trace	17.2	130	1901	17.0 ± 0.6	0.11	52.4 ± 2.7	11.8 ± 1.8	32.3 ± 1.9	3.5 ± 1.8
Apr. 8-12	90	0.02	20.0	152	3060	12.0 ± 0.6	0.05	60.8 ± 3.1	8.4 ± 2.5	28.3 ± 2.6	2.5 ± 2.5
Apr. 22-25	64	0.30	18.85	143	2051	13.7 ± 0.6	0.09	61.3 ± 2.6	10.2 ± 2.2	25.6 ± 2.3	2.9 ± 2.2
Apr. 29-May 2	66	0.79	18.9	143	2121	6.2 ± 0.6	0.04	56.5 ± 5.6	9.7 ± 4.9	33.8 ± 5.0	0.0 ± 4.9
May 6-9	65	0.22	19.05	144	2105	24.8 ± 0.6	0.15	52.4 ± 2.1	12.9 ± 1.3	31.9 ± 1.5	2.8 ± 1.2
May 13-16	65	0.14	18.3	139	2023	17.9 ± 0.6	0.11	55.9 ± 2.6	10.1 ± 1.7	32.4 ± 2.0	1.6 ± 1.7
May 16-18	52	0.06	18.8	143	1662	31.0 ± 0.6	0.24	59.7 ± 1.8	12.9 ± 1.0	26.8 ± 1.1	0.6 ± 1.1
May 18-20	51	1.05	19.0	144	1647	30.3 ± 0.6	0.23	59.7 ± 1.8	8.9 ± 1.0	28.4 ± 1.1	3.0 ± 1.0
May 20-23	65.5	0.01	19.2	145	2138	42.6 ± 0.7	0.25	52.3 ± 1.3	13.4 ± 0.8	30.0 ± 0.9	4.3 ± 0.7
May 23-25	51	0.01	19.0	144	1647	21.9 ± 0.7	0.17	61.2 ± 3.0	7.3 ± 1.4	27.9 ± 1.7	3.6 ± 1.4
May 25-27	51.5	0.10	18.8	143	1646	80.5 ± 0.6	0.62	50.9 ± 0.6	6.3 ± 0.4	35.2 ± 0.6	7.6 ± 0.4
May 27-31	89.5	0.81	19.25	146	2929	66.5 ± 0.8	0.29	43.6 ± 1.1	7.8 ± 0.5	40.6 ± 0.8	8.0 ± 0.5
May 31-June 3	79	trace	18.75	143	2518	22.9 ± 0.7	0.12	62.9 ± 2.6	10.0 ± 1.4	27.1 ± 1.6	0.0 ± 1.3
June 3-6	68	0.0	18.75	143	2168	55.3 ± 0.7	0.32	56.1 ± 1.0	9.6 ± 0.6	30.4 ± 0.8	3.9 ± 0.6
June 6-8	48	trace	18.85	143	1538	76.3 ± 0.7	0.63	51.1 ± 0.7	6.7 ± 0.4	35.4 ± 0.5	6.8 ± 0.4
June 8-10	51	0.12	19.25	146	1669	80.1 ± 0.6	0.61	52.4 ± 0.7	6.0 ± 0.4	34.6 ± 0.5	7.0 ± 0.4
June 10-13	66	0.0	19.0	144	2132	23.5 ± 0.6	0.14	54.5 ± 2.2	8.5 ± 1.3	32.8 ± 1.5	4.2 ± 1.3
June 17-20	65.5	0.01	18.5	141	2060	39.6 ± 0.6	0.24	51.0 ± 1.4	7.6 ± 0.8	37.1 ± 1.0	4.3 ± 0.8
June 23-24	23	0.0	17.4	132	680	26.6 ± 0.8	0.49	—	—	—	—
June 24-27	65	0.0	19.4	147	2144	58.5 ± 0.8	0.35	51.8 ± 1.0	8.5 ± 0.5	37.3 ± 1.0	2.4 ± 0.5
July 1-5	90	0.0	18.85	143	2885	69.3 ± 0.8	0.30	42.9 ± 0.9	8.5 ± 0.5	42.9 ± 0.8	5.7 ± 0.5
July 8-11	65.5	0.0	18.85	143	2099	40.1 ± 0.7	0.24	44.6 ± 1.3	9.0 ± 0.8	41.1 ± 1.3	5.3 ± 0.8
July 22-25	65.5	trace	18.95	144	2110	29.7 ± 0.7	0.18	46.1 ± 1.8	9.4 ± 1.0	38.7 ± 1.7	5.8 ± 1.0

*Collections made on several different sets of equipment.
†Total count rate for all filters in pack; overall counting efficiency for 4-in.-diameter filters was 3.56 percent for 1 MeV β's.
‡In some cases glass-fiber filters (Gelman Type A) were used in this position.
(s) Snow (water equivalent).

Table 2
Results of Radiochemical Analyses of Filter Pack Collections at NRL, Washington, D.C., During 1965 and 1966

Collection Date	Sample Volume (m^3)	Filter	Radioactivity Distribution (%) on Filters								Selected Activity Ratios			
			Sr^{89}	Sr^{90}	Y^{91}	Cs^{137}	Ce^{141}	Ce^{144}	Pm^{147}	Pb^{210}	Ce^{144}/Pm^{147}	Ce^{144}/Sr^{90}	Cs^{137}/Sr^{90}	Pb^{210}/Sr^{90}
1965 February (Feb. 1-Mar. 1)	1.74×10^5	(1) IPC 1478	28.0	48.5	39.0	54.1	*	45.9	42.4	8.1	1.73	4.79	1.27	0.11
		(2) Type 5G	68.6	49.8	54.4	43.7	*	52.0	52.5	68.1	1.59	5.30	1.00	0.90
		(3) Whatman GF/A	3.4	1.7	6.6	2.2	*	2.1	5.1	23.8	0.66	6.24	1.46	9.3
		Total Activity‡ (10^3 dis/min)	1.88	6.45	0.331	7.36	*	32.7	20.4	4.25	1.60	5.07	1.14	0.66
May (May 3-May 31)	1.74×10^5	(1) IPC 1478	67.4	42.7	63.1	63.5	*	42.2	35.9	16.1	1.84	4.04	2.34	0.14
		(2) Type 5G	24.2	55.2	28.7	34.0	*	55.1	62.2	59.7	1.39	4.08	0.97	0.40
		(3) Whatman GF/A	8.4	2.1	8.2	2.5	*	2.7	1.9	24.2	2.21	5.32	1.93	4.3
		Total Activity‡ (10^3 dis/min)	6.33	8.93	3.01	14.05	*	36.5	23.3	3.32	1.56	4.09	1.57	0.37
August (Aug. 2-16; Aug. 23-Sept. 8)†	1.86×10^5	(1) IPC 1478	*	53.7	34.9	62.8	*	49.5	49.6	14.7	1.25	2.85	1.52	0.07
		(2) Type 5G	*	45.2	54.1	35.4	*	48.9	48.6	57.0	1.26	3.35	1.02	0.32
		(3) Whatman GF/A	*	1.1	11.0	1.8	*	1.6	1.8	28.3	1.05	4.38	2.20	6.8
		Total Activity‡ (10^3 dis/min)	*	4.23	0.45	5.48	*	13.06	10.43	1.08	1.25	3.09	1.30	0.26
November (Nov. 1-Nov. 29)	1.74×10^5	(1) IPC 1478	*	58.7	*	62.4	*	53.4	56.9	8.4	1.03	2.32	1.71	0.52
		(2) Type 5G	*	40.3	*	35.6	*	45.6	41.9	76.9	1.20	2.89	1.42	6.9
		(3) Whatman GF/A	*	1.0	*	2.0	*	1.0	1.2	14.7	0.93	2.79	3.42	56.0
		Total Activity‡ (10^3 dis/min)	*	1.99	*	3.21	*	5.09	4.63	7.27	1.10	2.56	1.61	3.65
1966 February (Feb. 1-8; Feb. 15-Mar. 2)†	1.80×10^5	(1) IPC 1478	*	51.2	*	56.7	*	53.1	55.6	18.9	1.03	2.22	1.79	0.54
		(2) Type 5G	*	47.8	*	41.8	*	46.2	43.0	55.3	1.16	2.07	1.41	1.68
		(3) Whatman GF/A	*	1.0§	*	1.5§	*	0.7	1.4	25.8	0.62	(1.7)	(2.5)	39.0
		Total Activity‡ (10^3 dis/min)	*	(2.09)	*	(3.37)	*	4.48	4.14	3.04	1.08	(2.14)	(1.61)	1.45
May (May 2-June 1)	1.92×10^5	(1) IPC 1478	23.6	39.8	52.0	44.9	60.0	51.0	47.2	18.3	1.01	1.96	1.36	0.05
		(2) Type 5G	46.3	58.4	33.7	52.5	27.6	47.0	50.4	56.9	0.87	1.23	1.08	0.10
		(3) Type 6	30.1	1.8	14.3	2.6	12.4	2.0	2.4	24.8	0.81	1.74	1.73	1.45
		Total Activity‡ (10^3 dis/min)	3.52	5.43	5.14	6.53	9.01	8.30	8.90	0.57	0.93	1.53	1.20	0.10

*Not detectable above background of other activity; ( ) uncertain value.
†Weekly collection discarded because of wet filters.
‡Activity corrected for decay to midpoint of sampling period.
§Estimated value; sample lost during processing.

$$\left.\begin{aligned} A_1 &= 95.00\,x_1 + 20.00\,x_2 + 2.00\,x_3 \\ A_2 + A_3 &= 5.00\,x_1 + 78.30\,x_2 + 39.96\,x_3 \\ A_4 &= 0.00\,x_1 + 1.70\,x_2 + 58.04\,x_3 \end{aligned}\right\} . \qquad (2)$$

Two collections of radon decay products and 16 fission-product collections made in 1963, when radioactivity levels were high, have been interpreted in terms of both 3 and 4 size groupings in Table 3. Similar agreement was obtained for 42 additional collections of fission products made during 1964. Nominally, in the 4-group designation the x values represent assignments to size groups centered around 1.1μ, 0.6μ, 0.3μ, and 0.15μ diameters; in the 3-group designation the x values refer to particle size ranges of >1.0μ, 1.0-0.3μ, and <0.3μ diameters, respectively. Again, it is emphasized that these size ranges have been rather arbitrarily selected; however, they are realistic in that they are in accord with the measured retention characteristics of the individual filters toward spherical aerosols of 1.8 g/cc density (1).

Table 3
Comparison of Radioactivity Size Distributions Interpreted in Terms of Three and Four Size Groupings

Collection Date*	Radioactivity Distribution (%)				Size Distribution of Radioactivity (%)						
					4 Size Groups‡				3 Size Groups§		
	A_1	A_2	A_3	A_4	x_1	x_2	x_3	x_4	x'_1	x'_2	x'_3
1963											
Jan. 18-21	51.34	8.68	36.22	3.76	45.29	16.03	34.16	4.52	42.98	52.07	4.95
Mar. 1-4	33.60	9.01	52.98	4.41	25.45	11.65	58.41	4.49	19.43	75.18	5.40
Apr. 19-22	27.80	7.80	57.05	7.35	21.14	2.74	67.17	8.95	12.90	76.68	10.42
Sept. 20-23	36.06	11.42	49.43	3.09	23.81	30.26	43.11	2.83	22.17	74.70	3.14
Sept. 27-30	27.32	11.29	58.10	3.29	14.57	25.66	57.36	2.42	10.51	86.35	3.14
Oct. 4-7	26.25	11.46	58.59	3.70	13.07	26.98	56.81	3.15	9.25	86.92	3.83
Oct. 18-21	45.96	11.33	41.47	1.24	34.83	31.87	33.10	0.20	34.67	65.10	0.23
Oct. 25-28	38.74	11.92	46.40	2.94	25.81	35.21	36.03	2.96	25.70	71.32	2.98
Nov. 1-4	34.82	13.97	48.30	2.91	17.83	49.63	29.29	3.24	20.42	76.81	2.76
Nov. 8-12	36.36	12.37	48.35	2.92	22.41	37.70	37.03	2.86	22.50	74.66	2.84
Nov. 15-18	32.23	12.64	53.11	2.02	17.52	37.05	44.55	0.88	16.56	82.37	1.07
Nov. 19-22	41.72	11.95	44.97	1.37	29.10	35.05	35.57	0.28	29.03	70.70	0.27
Nov. 22-26	35.05	12.41	50.54	2.01	20.99	36.47	41.50	1.05	20.34	78.51	1.15
Dec. 13-16	39.70	13.86	44.52	1.92	23.39	49.81	25.05	1.76	26.55	72.26	1.19
Dec. 20-24	43.87	12.43	41.68	2.02	30.50	40.45	27.22	1.82	32.20	66.26	1.54
Dec. 27-31	42.21	11.63	44.33	1.83	30.18	33.24	35.51	1.08	29.89	68.98	1.13
Mar. 15†	9.00	4.30	48.20	38.50	4.80	0.48	30.05	64.68	1.02	33.63	65.35
Mar. 27†	9.91	5.69	50.57	33.83	3.61	6.80	33.16	56.44	0.24	42.73	57.04

*Detailed information on these collections is given in Ref. 3.
†RaB plus RaC collections.
‡Groups x_1 through x_4 refer to sizes 1.1, 0.6, 0.3, and 0.15μ dia., respectively.
§Groups x'_1 through x'_3 refer to size groupings >1.0, 1.0-0.3, and <0.3μ dial, respectively.

A few filter collections made several years ago employed 3-filter packs (IPC 1478/Type 5G/Type 6) but otherwise were carried out under the standard flow condition of approximately 145 cm/sec. For analysis of this data, system (2) has been reduced to the following set of equations by redistributing the contribution of the 2nd IPC filter (A_2) between the 3rd and 4th filters:

$$\left.\begin{aligned} A_1 &= 95.00\,x_1 + 20.00\,x_2 + 2.00\,x_3 \\ A_2 &= 5.00\,x_1 + 77.90\,x_2 + 38.78\,x_3 \\ A_3 &= 0.00\,x_1 + 2.10\,x_2 + 59.22\,x_3 \end{aligned}\right\} . \qquad (3)$$

Some results of these collections are listed in Table 4. These results are in agreement with those generally found with 4-filter packs and differ only in detail from the previous analysis of the data (1) determined through use of a somewhat different set of equations.

Table 4
Distribution of Radioactivity with Particle Size
Determined from a Three-Filter Pack

Collection Date	Air Flow (cm/sec)	Radioactive Distribution on Filters (%)			Size Distribution of Radioactivity (%)		
		1. IPC	2. Type 5G (2)	3. Type 6	>1.0 μ	1.0-0.3 μ	<0.3 μ
Oct. 19, 1962*	145	7.0	53.9	39.1	-1.80	37.09	64.71
Nov. 11-13, 1962	142	65.92	28.52	5.56	63.24	28.38	8.38
Nov. 23-26, 1962	143	72.62	24.64	2.74	71.06	25.21	3.73
Jan. 25-28, 1963	143	51.82	45.03	3.15	43.25	53.32	3.43
Feb. 1-4, 1963	142	47.42	48.58	4.00	37.69	57.60	4.71
Apr. 5-8, 1963	142	30.43	64.79	4.78	15.17	79.58	5.25
Aug. 30-Sept. 3, 1963	146	29.76	66.57	3.67	13.79	82.95	3.26
Sept. 13-16, 1963	148	38.68	58.97	2.35	25.23	73.40	1.37

*Collection of short-lived radon decay products.

Of more pertinence to the overall problem is the development of sets of equations to analyze the radioactivity distributions of collections obtained under other flow conditions. A set of equations which appeared to be useful at a linear velocity of 60 cm/sec (and also at 70 cm/sec) was developed through comparison of results of simultaneous 4-filter pack collections made at 60 (or 70) cm/sec and at the standard flow condition (ca. 145 cm/sec). Both packs were treated as though they were 3-filter collections; the standard pack was analyzed through use of system (2), while the 60-70 cm/sec collections were analyzed through use of the following set of equations:

$$\left.\begin{aligned} A_1 &= 55.00\,x_1 + 10.00\,x_2 + 2.00\,x_3 \\ A_2 + A_3 &= 45.00\,x_1 + 82.25\,x_2 + 30.00\,x_3 \\ A_4 &= 0.00\,x_1 + 7.75\,x_2 + 68.00\,x_3 \end{aligned}\right\} . \qquad (4)$$

Results of these two sets of analyses are listed in Table 5. While some pairs of results are in rather good agreement, others show considerable divergence. Even in these latter cases, however, the general pattern of the size distribution of the airborne radioactive particles, with the major part of the activity associated with particles in the 1.0-0.3 μ range, is recognizable.

The lack of quantitative agreement between duplicate collections is not surprising, since there is no way to take into account the fine structure of the size distribution spectrum. The boundaries of the size groups have been rather arbitrarily set at 1.0 μ and 0.3 μ diameter, but the filters themselves do not have sharp cutoff points at these sizes;

Table 5
Interpretation of Size Distribution of Airborne Radioactive Particles from Collections Made at Different Flow Velocities

Collection Date	Air Flow (cm/sec)	Radioactivity Distribution on Filters (%)*				Size Distribution of Radioactivity (%)		
		A_1	A_2	A_3	A_4	x_1 ($>1.0\mu$)	x_2 (1.0-0.3μ)	x_3 ($<0.3\mu$)
Sept. 20-23, 1963	144	36.06	11.42	49.43	3.09	22.17	74.70	3.14
	60	17.62	7.14	65.80	9.44	17.84	77.06	5.10
Oct. 25-28, 1963	144	38.74	11.92	46.40	2.94	25.70	71.32	2.98
	60	20.58	8.84	61.19	9.40	24.56	69.54	5.90
Nov. 1-4, 1963	147	34.82	13.97	48.30	2.91	20.42	76.81	2.76
	60	16.18	7.21	66.47	10.14	14.78	79.36	5.86
Nov. 8-12, 1963	144	36.36	12.37	48.35	2.92	22.50	74.66	2.84
	60	19.04	7.56	63.62	9.78	21.17	72.74	6.09
Nov. 15-18, 1963	144	32.23	12.64	53.11	2.02	16.56	82.37	1.07
	60	15.18	8.44	68.31	8.07	11.88	86.06	2.06
Dec. 20-24, 1963	144	43.87	12.43	41.68	2.02	32.20	66.26	1.54
	69	20.08	9.65	64.09	6.18	22.45	77.27	0.28
Jan. 17-21, 1964	145	50.95	12.80	34.72	1.53	41.49	57.55	0.95
	71	24.76	10.15	58.33	6.76	33.27	64.10	2.64
Mar. 6-9, 1964	146	43.32	14.34	40.39	1.95	31.43	67.18	1.39
	72	19.17	9.77	62.79	8.27	21.01	75.42	3.57
Mar. 13-16, 1964	146	43.70	15.29	38.52	2.49	32.17	65.46	2.37
	72	18.32	10.00	64.51	7.17	18.75	79.80	1.45
Mar. 20-23, 1964	146	45.44	13.60	39.20	1.76	34.19	64.67	1.14
	72	23.45	8.80	59.25	8.50	30.81	63.98	5.21
Mar. 24-27, 1964	145	42.63	10.60	44.11	2.66	30.81	66.56	2.63
	71	20.16	9.00	62.59	8.25	23.26	72.92	3.82
Apr. 3-7, 1964	146	39.03	13.05	45.75	2.17	25.76	72.63	1.61
	70	18.93	9.29	63.81	7.97	20.38	76.64	2.98
Apr. 7-10, 1964	143	33.30	12.78	52.01	1.91	17.95	81.13	0.91
	70	18.12	9.46	66.02	6.40	18.06	81.86	0.08
Apr. 10-13, 1964	144	35.33	11.85	50.69	2.13	20.77	77.84	1.39
	70	19.02	8.84	65.67	6.47	20.13	79.41	0.46
May 1-4, 1964	147	37.90	11.42	47.52	3.16	24.67	72.00	3.34
	70	22.14	8.20	60.44	9.22	28.05	65.90	6.05
May 8-11, 1964	149	38.42	9.93	47.67	3.98	25.72	69.46	4.82
	70	19.23	7.74	62.17	10.86	21.93	70.09	7.98
May 22-25, 1964	149	41.02	11.06	45.22	2.70	28.66	68.70	2.64
	70	20.70	9.76	61.41	8.13	24.45	71.78	3.77

*Filter arrangement: IPC 1478/IPC 1478/Type 5G/Type 6.

consequently, material in a size range close to the "cutoff" point may be split between the filters in a manner different from the expected "average" behavior of particles in these size ranges.

One feature observable in the data in Table 5 is that the percentage of activity retained on the top filter (IPC 1478) is roughly equal to the assigned component in the $>1.0\mu$ size group when filtration is carried out at 60-70 cm/sec. Thus a simple 2-filter pack of IPC 1478 over an absolute filter, when operated at an air velocity of 60-70 cm/sec, can be expected to give useful information on those particles having a nominal size in excess of 1.0μ diameter (assuming spherical particles of 1.8 g/cc density). Similarly, a rough measure of the $<0.3\mu$ component can be obtained from the fraction of activity which penetrates a single Type 5G filter and is retained by a second, absolute filter when the two-filter pack is operated at flow rates near 145 cm/sec.

CONCLUSIONS

The described filter pack method can be employed to give useful information on the size distribution of radioactive atmospheric aerosols; while not a quantitative procedure, the method is satisfactory for determining the relative amounts of material in several loosely defined size groups and, particularly, for observing changes in the particle size distribution with time.

Conditions have been developed for obtaining size distributions through use of packs consisting of 3 or 4 well-characterized filter media operated in two convenient air flow regimes, 60-70 cm/sec and 145 cm/sec. Simpler, two-filter packs can be employed to monitor the behavior of particulate matter in two restricted size ranges: (a) the fraction of total radioactivity retained on an IPC 1478 filter relative to a backup absolute filter at air velocities of 60-70 cm/sec is a rough measure of the radioactivity attached to $>1.0\mu$-diameter particles; (b) the fraction of total radioactivity penetrating a Type 5G filter and retained on an absolute filter at an air velocity near 145 cm/sec is a measure of the radioactivity attached to $<0.3\mu$-diameter particles. This procedure is valid for the approximate size analysis of airborne radioactive particles in a normal atmospheric sample; however, a large degree of bias may be encountered in the analysis of artificial atmospheres which contain quantities of particles in rather restricted size groups. In this latter case, though, changes in the degree of retention with time still would be indicative of changes in the particle size distribution. This method is not limited to radioactive particulate matter but is applicable to any material for which suitable analytical techniques are available.

Finally, fission product radioactivity in the atmosphere in the environs of Washington, D.C., has continued to decrease during the period December 1965 through July 1966, in spite of small additions of debris from nuclear tests held on the mainland of China. No significant changes in size distribution or in isotope fractionation have been observed.

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Appendix A

EVALUATION OF EFFECT OF DUST LOADING ON FILTER RETENTIVITY

In view of the dependence of the filter pack method of size analysis on the filter characteristics, it was considered desirable to evaluate directly the effect of dust loadings of the magnitude obtained in routine collections on the filter retentitivity. In mid-1966, when this was accomplished, the concentrations of airborne fission products were so low that it was necessary to employ instead the short-lived decay products of atmospheric radon.

The β-emitting radon daughters RaB (Pb^{214}) and RaC (Bi^{214}) were collected on simple 2-filter packs* employing either a clean or a previously used filter backed up by an absolute filter (Gelman A glass-fiber filter). Collections were of 30 minutes duration; counting was begun immediately with filters counted in sequence on the same counter and corrected for decay to a common time. A small correction was also required for the residual radioactivity remaining in the previously exposed filters:

$$\text{filter efficiency (\%)} = \frac{\text{activity (c/m) of tested filter}}{\text{activity (c/m) of tested filter} + \text{activity (c/m) of absolute filter}} \times 100.$$

The results of these evaluations, listed in Table A1, clearly indicate that dust loadings of the magnitude encountered during periods in April and May 1966, which are typical, cause no significant change in the effectiveness of the filters towards the small airborne dust particles ($<0.3\mu$ diameter) to which the radon decay products become attached. Minimal changes in the retentivity of 0.3μ-diameter DOP smokes have also been found to result from the degree of dust loading encountered in other filter pack collections, as shown in Table A2.†

A series of 15 collections of atmospheric dust on weighed glass-fiber filters during February and March 1964 indicated dust loadings of 0.29 to 0.82 mg/cm^2 per day (average 0.48 mg/cm^2 per day) when sampled at a linear velocity of 150 cm/sec. Filter pack collections made during this same period of higher-than-average dust concentrations showed flow decreases of 6 to 9 percent for 4 days exposure, the largest flow decrease corresponding to a measured dust loading of 2.4 mg/cm^2. It can thus be inferred that the dust loading normally encountered in this environment during a 3 or 4 day collection on the described 4-filter pack will rarely decrease the air flow by as much as 10 percent, nor will it materially change the filter retentivity toward small (0.3μ diameter) airborne particles; moreover, β absorption curves indicate that the collected dust would not depress the observed β count to any significant extent (<5 percent for β's of 1.0 MeV energy (E_{max})) even if all of the dust were concentrated on a single filter in the pack.

*For details of the method see L. B. Lockhart, Jr., R. L. Patterson, Jr., and W. L. Anderson, "Characteristics of Air Filter Media Used for Monitoring Airborne Radioactivity," NRL Report 6054, Mar. 20, 1964.

†W. L. Anderson, Protective Chemistry Branch, NRL, personal communication.

Table A1
Effect of Previous Exposure of Filters on Their Retention Efficiency
Toward Radon Decay Products (RaB and RaC)

Filter	Filter Condition	RaB + RaC Collection		Air Flow (cm/sec)	Measured Retention (%)†
		Date	Time		
IPC 1478	Used (Initial filter in pack 1)*	7-12-66	0940-1020	156	10.7 ± 0.7
	Unexposed	7-12-66	1025-1055	156	8.8 ± 0.7
	Used (Second filter in pack 1)*	7-12-66	1205-1235	156	8.2 ± 0.6
	Unexposed	7-12-66	1250-1320	156	9.9 ± 0.6
	Used (Second filter in pack 2)*	7-13-66	0920-0950	160	8.3 ± 0.5
	Unexposed	7-13-66	1005-1035	156	7.9 ± 0.6
	Used (Initial filter in pack 3)*	7-13-66	1150-1220	160	8.7 ± 0.8
Type 5G	Used (Third filter in pack 1)*	7-13-66	0815-0845	148	61.7 ± 1.1
	Unexposed	7-13-66	0845-0915	148	59.3 ± 1.3
	Used (Third filter in pack 2)*	7-13-66	1200-1230	148	60.0 ± 1.1

*Filter pack: IPC 1478/IPC 1478/Type 5G/Type 6 (or Gelman A)
Pack 1 exposed Apr. 29-May 2, 1966 (66 hours, flow change 2.3%);
Pack 2 exposed Apr. 29-May 2, 1966 (66 hours, flow change 8.1%);
Pack 3 exposed Apr. 8-12, 1966 (90 hours, flow change 4.7%).
†Corrected for background of radioactivity in the filter. The uncertainty is the statistical error (standard deviation) due to counting.

Table A2
Effect of Previous Exposure of Filters on Their Retention Efficiency
Toward 0.3μ-diameter DOP Aerosol*

Filter	Position in Exposed Pack†	Filter Retention (%)		
		Filters from Exposed Packs		Unexposed Filters
		Pack A	Pack B	
IPC 1478	1	12	13	10
	2	11	11	
Type 5G	3	70	70	69
Gelman A	4	99.99	99.99	99.98

*Air flow 28 linear ft/min (14.2 cm/sec).
†Filter arrangement: IPC 1478/IPC 1478/Type 5G/Gelman A
Pack A exposed 25-28 February 1966 (64 hours, flow change 5.5%)
Pack B exposed 10-13 June 1966 (66 hours, flow change 6.1%).

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13. ABSTRACT

During the past several years, a number of collections of radioactive aerosols in the atmosphere have been made on packs of filters, of different characteristics, through which an air stream passes sequentially. The radioactivity distribution on the filters has been related to the sizes of the particulate matter in the atmosphere with which the radioactivity was associated.

Conditions have been developed for obtaining size distributions in 3 or 4 size groups, in the submicron range, through use of packs consisting of 3 or 4 well-characterized filter media operated in two convenient air flow regimes, 60-70 cm/sec and 145 cm/sec. Simple two-filter packs can be employed to monitor the behavior of particulate matter in a restricted size range (e.g., either the $>1.0\mu$-diameter component or the $<0.3\mu$-diameter component). The general method is applicable to the sizing of any aerosol material for which suitable analytical techniques are available.

Gross β activity levels and concentrations of specific radionuclides in the atmosphere at Washington, D.C., have been documented for the period January 1965 through July 1966.

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