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December 18, 1959

C 127

Mr. J. Z. Holland, Chief
Fallout Studies Branch
Atomic Energy Commission
Division of Biology and Medicine
Washington 25, D. C.

Subject: Report No. ARF 3127-10 (Letter Report)
Contract No. AT (11-1)-626

Dear Mr. Holland:

I. INTRODUCTION

This is the tenth letter report on ARF Project C 127, entitled "Preliminary Studies of Scavenging Systems Related to Radioactive Fallout." This report covers the period from October 1 to December 1, 1959.

II. PHASE I - AIR SAMPLING

During this report period two cyclone separator tests have been completed and sent to the New York Operations Office of the Atomic Energy Commission for analyses. The current Andersen sampler test has processed about 80,000 cu ft of air to date.

The radioactivity associated with the dry atmospheric particles classified by the Andersen samplers during the period from June 1 to September 8, 1959, is listed in Table 1. The total beta activity was 1935 $\mu\text{mc}/100,000$ cu ft and the strontium-90 activity was 78.5 $\mu\text{mc}/100,000$ cu ft. About 60% of the total activity was due to the fine particles passing the Andersen sampler and collected on the millipore filters. The average activity levels of three previous tests were 1655 $\mu\text{mc}/100,000$ cu ft and 55.1 $\mu\text{mc}/100,000$ cu ft for total beta and strontium-90, respectively.

The data in Table 2 give the radioactivity of dry particulate matter classified by the cyclone separators. These results are the first obtained on

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weighed fractions of particles. The data show each gram of particulate matter has 5582 μmc of total beta activity and 297 μmc of strontium-90 activity. On a volume basis the data show levels of 890 $\mu\text{mc}/100,000$ cu ft and 40.1 $\mu\text{mc}/100,000$ cu ft for total beta and strontium-90 activity, respectively. Previous data averaged 5367 and 34.5 $\mu\text{mc}/100,000$ cu ft, respectively.

Table 1

RADIOACTIVITY ASSOCIATED WITH DRY ATMOSPHERIC PARTICLES
CLASSIFIED BY THE ANDERSEN SAMPLERS FROM JUNE 1 TO SEPTEMBER 8, 1959

Particle Size	Total Beta Activity		Strontium-90 Activity	
	$\mu\text{mc}/100,000$ cu ft	%	$\mu\text{mc}/100,000$ cu ft	%
>7 microns	28	1.4	2.1	2.7
5.5-10 microns	13	0.6	1.1	1.4
3.5-5.5 microns	23	1.2	1.2	1.5
2.0-3.5 microns	40	2.1	3.3	4.2
1.0-2.0 microns	363	18.8	15.1	19.2
<1 micron	261	13.5	11.9	15.2
Millipore filter	1207	62.4	43.8	55.8
	1935	100.0	78.5	100.0

Table 2

RADIOACTIVITY ASSOCIATED WITH DRY ATMOSPHERIC PARTICLES
CLASSIFIED BY CYCLONE SEPARATORS FROM JULY 28 TO AUGUST 17, 1959

Particle Size Separation Unit	Total Beta Activity				Strontium-90 Activity			
	Per 100,000 cu ft		Per gram		Per 100,000 cu ft		Per gram	
	μmc	%	μmc	%	μmc	%	μmc	%
Rough cyclone	11.3	1.2	112	2.0	1.1	2.7	10.4	3.7
Small cyclone	72.7	8.2	1231	22.1	5.4	13.5	91.9	32.9
Millipore filter	806.0	90.6	4239	75.9	33.6	83.8	177.0	63.4
	890.0	100.0	5582	100.0	40.1	100.0	279.3	100.0

III. PHASE II - LABORATORY STUDIES OF SCAVENGING SYSTEMS

The results of a laboratory study on the scavenging of aerosol particles by evaporating and condensing water droplets are presented in Table 3. A fluorescent zinc sulfide aerosol was used. The mean particle diameter by count was 1.14 microns and the mean volume diameter 1.34 microns. The percentage capture is based on the number of particles captured divided by the total number of the particles which passed beneath the cross sectional area of the droplet projected at a right angle to the direction of flow. The number of particles which theory predicts would have been captured by interception, inertia, and Brownian motion are listed also for comparison with the number actually captured.

To effect changes in droplet size, several conditions of humidity were used. Relatively dry air was used for evaporation tests and almost saturated air for static growth tests. To make the droplet grow it was necessary to cool the droplet and line the chamber with wet blotting paper in addition to using humid air.

The aerosol was generated with the Wright dry dust feeder and drawn through a 57-mm-diameter glass chamber at a rate of 0.5 cm/sec. The aerosol was sampled with a Strong-Ficklen oscillating thermal precipitator. The water droplet was hung in the chamber from an electrically grounded gold wire 0.02 in. in diameter. The change in droplet diameter was observed with a telescope fitted with a calibrated Filar-type micrometer eyepiece. After exposure to the aerosol the droplet was collected on a black millipore filter and the water removed immediately by suction. The captured particles on the surface of the filter were counted by visual observation at 160x magnification under reflected ultraviolet light in the 4000-Å region. The aerosol concentration was estimated from thermal precipitator slides observed under the same magnification and light source.

The sizes and distributions of the aerosol and the captured particles are shown in Fig. 1. The loss of large aerosol particles in the aerosol handling system prior to the test chamber is apparent from the skewed curve of the aerosol particle distribution. The presence of larger particles among the captured particles is the result of particle aggregation on the surface of the droplet. Photomicrographs from which these distributions were obtained are shown in Fig. 2.

Plots of droplet diameter versus time produced fairly straight lines, the slopes of which represent rate of growth or rate of evaporation of the droplet. A negative slope indicates an evaporating droplet and a positive slope a condensing droplet. The slopes are listed in Table 3. Figure 3 shows the relationship between the slope of the droplet growth curves and the percentage of particles captured. Collection efficiency increases sharply for condensing droplets but is relatively low when the droplet is evaporating. Thus, it appears that capture is extremely sensitive to changes in the growth rate of a droplet.

Table 3

CAPTURE OF ZINC SULFIDE AEROSOLS BY WATER DROPLETS

	Test No.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Air Velocity, cm/min	29	29	29	29	30	32	32	27	28	28	28	28	28
Temperature, °F	83	83	83	85	79	80	82	76	81	80	78	80	80
Relative Humidity, %	20	20	20	20	30	90	90	90	100	100	100	100	100
Test Duration, min.	13	15	12	12	12	15	14	13	10	12.5	10	10	10
Av. Droplet Diam., mm	1.71	1.85	2.10	1.90	2.10	1.78	1.81	2.10	1.87	1.69	2.10	2.05	2.10
Slope of Growth Curve, mm/min	-.057	-.047	-.037	-.039	.037	-.0043	-.0023	+.00008	+.009	+.011	+.014	+.019	+.013
Aerosol Conc., particles/cc	1300	64000	2515	5305	3520	5740	2238	752	3350	3550	2715	3720	699
Particles Captured: Number	101	4850	500	351	124	1103	455	306	1110	891	1751	2095	495
%	0.90	0.65	1.64	0.67	0.29	1.50	1.76	3.34	4.28	3.15	6.61	6.05	9.60
Theor. Particles Captured, number:													
Interception	27	1624	59	111	82	156	58	18	56	67	51	68	9
Inertia	0	0	0	0	0	0	0	0	0	0	0	0	0
Brownian motion	0	8	0	0	0	0	0	0	0	0	0	0	0

Fig. 1. PARTICLE SIZE DISTRIBUTION OF ZINC SULFIDE
AEROSOL PARTICLES AND OF AEROSOL PARTICLES
CAPTURED BY WATER DROPLETS

Aerosol Particles

Fig. 2. PHOTOMICROGRAPHS OF ZINC SULFIDE AEROSOL
PARTICLES AND OF AEROSOL PARTICLES CAPTURED BY WATER
DROPLETS

Fig. 3. EFFECT OF VAPOR GRADIENT ON PARTICLE CAPTURE.

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IV. FUTURE WORK

Air sampling with both the Andersen and the cyclone samplers will continue. The effect of condensation or evaporation of water droplets on capture of 0.1- to 1-micron particles will be evaluated.

V. LOGBOOKS AND PERSONNEL

The data reported here are contained in ARF Logbooks C 9230, C 9560, and C 9032. Mr. Sheldon Bernsen contributed to this project.

Respectfully submitted,

ARMOUR RESEARCH FOUNDATION
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