ARMOUR RESEARCH FOUNDATION OF ILLINOIS INSTITUTE OF TECHNOLOGY
TECHNOLOGY CENTER 10 WEST 35TH STREET CHICAGO 16, ILLINOIS CATALOG 5-9600

*Send to
Purman*

ARF-3127-8

RCO	JUN 2 1960
MASTER	
MILLER	
FREMLING	
STEFFEN	
SCHMIDT	
FORLEY	
PLESE	
FILE	
DESTROY	

August 20, 1959

C 127

Mr. J. Z. Holland, Meteorologist
Environmental Sciences Branch
Atomic Energy Commission
Division of Biology and Medicine
Washington 25, D. C.

Subject: Report No. ARF 3127-8 (Letter Report)
Contract No. AT(11-1)-626

Dear Mr. Holland:

I. INTRODUCTION

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

II. PHASE I - AIR SAMPLING

Separation of airborne particles into several size fractions for radioactive analysis is continuing. The volume of air sampled by the Andersen samplers during the current test is 58,749 cu ft. The cyclone and millipore filter unit sampled 95,068 cu ft of air between the period from May 11 to June 22. The collected dust was sent to the Atomic Energy Commission New York Operations Office on June 24.

Following this test a second, larger cyclone (Fig. 1) was placed ahead of the other cyclone to remove the larger particles from the airstream. With this roughing cyclone in the system, 103,581 cu ft of air was sampled during the period from July 2 to July 17. It was intended to precede the millipore filter with a Whatman No. 40 filter and obtain four size fractions, but the pressure drop through this filter was too great for the pump. The dust collected in each of the cyclones and on the millipore filter is presently being weighed before the samples are shipped to the New York Operations Office. Calibration data for the roughing cyclone are given in Table 1 and Fig. 2.

*5-6-7
still to come
telecon plinton
4/3/60*

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

August 20, 1959

Fig. 1. ROUGHING CYCLONE

029 302

Table 1

COLLECTION EFFICIENCY OF THE ROUGHING CYCLONE

Diameter of Particles, μ	Number of Particles		% of Particles	
	In Inlet Air	In Exit Air	Retained	Passed
1-1.4	2,389	2,126	11	89
1.4-2	1,403	1,084	23	77
2-2.8	897	461	48	52
2.8-4	676	251	63	37
4-5.6	230	61	74	26
5.6-8	85	10	88	12

The data in Table 1 were obtained with room air by using the ARF electronic particle counter. With Arizona road dust, particles larger than 16 microns in diameter were completely retained in the large cyclone. For comparison, the retention efficiency of the small cyclone for the particle sizes in Table 1 is 9, 20, 59, 92, 100, and 100%, respectively.

III. PHASE II - LABORATORY STUDY OF SCAVENGING SYSTEMS

The latex suspension received from the Dow Chemical Company was diluted 1,500 and the diluted suspension atomized with a Lauterbach generator. The generator used about 3000 cc/min of dry air. The wet aerosol was mixed with 18,400 cc/min of dry, filtered air and passed into a 5-liter flask. Of this aerosol 495 cc/min was drawn through a glass coil in a 20°C constant temperature bath and into the water-jacketed (20°C) test chamber containing the droplet hung from an 0.020-in.-diameter gold wire. Here, the aerosol concentration was obtained by drawing 20 cc/min of air through a Strong-Ficklen oscillating thermal precipitator. The air velocity in the chamber is 0.312 cm/sec. After the aerosol passed through the chamber, the relative humidity and electrical charge were measured with wet and dry-bulb thermometers and a Keithley model 610 electrometer.

Two tests were conducted to determine the efficiency of an evaporating water droplet for capturing 0.188-micron-diameter polystyrene latex particles. The results are given in Table 2. In Test B an alpha particle emitter, polonium, was placed near the entrance to the drop chamber. By ionizing the air some neutralization of charge on the aerosol particles was expected. However, though a marked difference in the results of the two experiments, calculation showed that electrostatic collection was the main mechanism of capture in both tests.

August 20, 1959

Fig. 2. RELATION BETWEEN FLOW AND PRESSURE DROP
IN THE ROUGHING CYCLONE

Table 2

COLLECTION OF POLYSTYRENE PARTICLES BY AN EVAPORATING WATER DROPLET

Test	Duration, min	Aerosol		Droplet		Particles Captured	Gross Collection Efficiency,* %
		R.h., %	Conc., particles/cc	Diam., mm Initial	Final		
A	13.5	50-60	7990	1.87	1.87	19,600	80.2
B	20	50-60	1490	2.21	1.57	4,500	22.4

*Based on an arithmetic mean cross section area of a droplet.

The number of particles captured by the droplet was determined by allowing the droplet to evaporate on a clean slide and counting the particles in a darkfield microscope at 400x. Normally, liquid particles form a background film and are invisible, but with specially cleaned slides they exist as discrete particles capable of scattering light. Because the droplet becomes contaminated during its evaporation, a clean water droplet was placed on the slide next to the test droplet and used as a blank. Stabilizer droplets were also counted in addition to the polystyrene spheres.

To circumvent the difficulties encountered with microscope counting, use of a Brice-Phoenix light-scattering photometer was investigated, but the instrument lacked the necessary sensitivity.

The use of a polystyrene latex suspension indicated that liquid atomization does not produce polystyrene particles of the desired size. The data in Table 3 show the size distribution of particles obtained by atomizing two latex suspensions and a 1% gelatin suspension. The latex suspensions were diluted 1:500, 1:100, and 1:10 and atomized from the Lauterbach generator. The aerosol was passed through a furnace into a 34-in.-diameter plastic sphere, where it was mixed with clean air. The aerosol was then sampled with the ARF particle counter. Distilled water atomized in this manner gave no counts.

Because the counter does not count particles below 0.5 microns, no counts with the 0.138-microns polystyrene spheres are expected. However, particles up to 2.8-microns in diameter were found. Heat treatment reduced the number and size distribution of the aerosol particles, but particles 1 micron in diameter were still present. Results were somewhat improved with 0.814-microns polystyrene, but although 30-50% of the particles were oversize when heat treated. After heat treatment, particles can grow in a humid atmosphere. Heating to 360°F apparently decomposed the aerosol.

The gelatin solution was atomized to show the particle distribution of the type of material often used to stabilize colloids. It is believed that the oversize particles are due to stabilizer particles which hold water tenaciously. Dr. Vanderhoff of the Dow Chemical Company states that the latex suspensions

Table 3

PARTICLE SIZE DISTRIBUTION OBTAINED BY ATOMIZATION OF LATEX AND GELATIN SUSPENSION

Suspension	Diluting Air, cfm	R.h. of Aerosol, %	Air Temp. after Heater, %	% of Airborne Particles after Atomization						Number of Airborne Particles/cc
				.5-.7 μ	.7-1 μ	1-1.4 μ	1.4-2 μ	2-2.8 μ	2.8-4 μ	
0.138- Latex diluted 1:500	0.5	10	75	45	27	17	9	2	0	90
	3.0	4	75	72	19	5	3	1	0	15
	5.5	4	75	90	8	1	1	0	0	4.2
	3.0	4	330	75	25	0	0	0	0	0.2
0.814- Latex diluted 1:100	3.0	4	75	12	24	52	12	0	0	109
		4	330	58	42	0	0	0	0	0.2
0.814- Latex diluted 1:10	3.0	4	75	3	13	36	33	13	2	500
		4	250	14	31	36	16	1	0	147
		4	330	57	30	12	1	0	0	3.2
		4	340	55	34	11	0	0	0	2.4
		4	360	0	0	0	0	0	0	0
-Size Latex	3.0	19	330	17	26	42	14	1	0	137
		19	350	33	34	29	4	0	0	52
		100	340	36	37	22	5	0	0	100
0.1% Gelatin	3.0	4	360	(a)	92	8	0	0	0	180
		4	395	(a)	95	5	0	0	0	53
		4	425	0	0	0	0	0	0	0

^aChannel out of order.

900 630 006

August 20, 1959

contain 7% polystyrene and 2% stabilizer of an undisclosed nature. The stabilizer is present in a quantity sufficient to place a monomolecular layer on the 0.318-micron particles. The results reported in Table 3, however, indicate that the stabilizer is present throughout the liquid.

Because of the difficulties associated with the microscope counts, some dysprosium salts have been purchased to simplify determination of a number of particles captured using neutron irradiation technique. Dysprosium has a high neutron cross section and can be detected in an amount of 10^{-11} g. The gamma decay of dysprosium nitrate can be followed on a 236 channel analyzer, and the beta decay of dysprosium chloride can be followed with a Tri-Carb liquid scintillation counter.

IV. FUTURE WORK

Air sampling will be continued. The dust collected by the cyclones and the millipore filter unit will be weighed before analysis.

Laboratory studies of scavenging systems will be directed toward elimination of charged aerosol particles and the use of radiochemical techniques for determining the amount of material collected by a water droplet.

V. RECORDS AND PERSONNEL

The data reported here are recorded in ARF Logbooks C 9032 and C 9030. Personnel who contributed to the project are S. Bernsen and G. Langer.

Respectfully submitted,

ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology

Stockham, Associate Chemist

John Rosinski, Senior Engineer

Approved by:

M. A. Fisher, Supervisor
Fine Particles Research

Mr. J. Z. Holland, Meteorologist - 8 -

August 20, 1959

Copy No. —

Distribution List:

<u>Copy No.</u>	<u>Recipient</u>
1 - 6	Mr. J. Z. Holland, Meteorologist Environmental Sciences Branch Atomic Energy Commission Division of Biology and Medicine Washington 25, D. C.
7	Dr. T. R. Hogness Chicago Midway Laboratory University of Chicago Chicago 37, Illinois
8	Dr. Wayne T. Sproull Western Precipitation Corporation 1000 West Ninth Street Los Angeles 54, California
9	Mr. Joachim Kuettnner Scientific Director Mt. Washington Observatory Gorham, New Hampshire
10	Dr. L. Silverman Harvard University Boston 15, Massachusetts
11	Dr. Lester Machta, Chief Special Projects Section U. S. Weather Bureau 24th & M Streets, N. W. Washington 25, D. C.
12	Dr. Luther B. Lockhart Head, Physical Chemistry Branch Chemistry Division U. S. Naval Research Laboratory Washington 25, D. C.
13	Mr. James Terrill, Chief Radiological Health Program Division of Sanitary Engr. Services Department of Health, Education and Welfare Public Health Service Washington 25, D. C.

DO NOT PHOTOCOPY

Copy No.

-
- 14 Mr. Sidney C. Stern
Principal Scientist
Mechanical Division
General Mills Incorporated
2003 East Hennepin Avenue
Minneapolis 13, Minnesota
- 15 Mr. H. J. DiGiovanni
Vice President
Del Electronics Corporation
521 Homestead Avenue
Mount Vernon, New York
- 16 Dr. S. K. Friedlander
Assistant Professor
Department of Chemical Engineering
The John Hopkins University
Baltimore, Maryland
- 17 Dr. E. A. Martell
Geophysics Research Directorate
Air Force Cambridge Research Center
Bedford, Massachusetts
- 18 Dr. S. A. Lough, Director
Health and Safety Laboratory
New York Operations Office
U. S. Atomic Energy Commission
70 Columbus Avenue
New York 23, New York
- 19 Dr. J. H. Harley
Health and Safety Laboratory
New York Operations Office
U. S. Atomic Energy Commission
70 Columbus Avenue
New York 23, New York
- 20 Dr. Kenneth Street
University of California
Radiation Laboratory
Livermore, California
- 21 Dr. Paul C. Tompkins
U. S. Naval Radiological Defense Laboratory
San Francisco 24, California

DO NOT PHOTOSTAT

August 20, 1959

<u>Copy No.</u>	<u>Recipient</u>
22	Dr. W. B. Harris Health and Safety Laboratory New York Operations Office U. S. Atomic Energy Commission 70 Columbus Avenue New York 23, New York
23	Dr. Frank H. Shelton Technical Director, AFSWP Department of Defense Washington 25, D. C.
24	Dr. George Cowan Los Alamos Scientific Laboratory Los Alamos, New Mexico
25	Dr. J. Turkevich Princeton University Princeton, New Jersey
26	Mr. Kermit Larson University of California P. O. Box 24164 W. Los Angeles 24, California
27	Dr. W. F. Libby U. S. Atomic Energy Commission Washington 25, D. C.
28	Mr. D. L. Northrup Technical Director Office for Atomic Energy, OCS/O Attention: AFOAT-1, Hdqs. USAF Tempo "X" Building Washington 25, D. C.
29	Dr. W. W. Kellogg The Rand Corporation Santa Monica, California
30	Armour Research Foundation Division C Files.

DO NOT PHOTOCOPY

Mr. J. Z. Holland, Meteorologist - 11 -

August 20, 1959

<u>Copy No.</u>	<u>Recipient</u>
31	Armour Research Foundation Editors, G. S. Gordon, K. F. Beal, L. C. Kinney, Main Files
32	Armour Research Foundation K. W. Miller, Report Library
33 - 36	Armour Research Foundation John Rosinski

JS:JR:do:sy

DO NOT PHOTOSTAT