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DISPERSION AND PENETRATION OF
POLLENS AND INDUSTRIAL CONTAMINANTS

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This report, not necessarily in final
scientific form, is intended only for the internal
management uses of the contractor and the Air Force.

Project 2160

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ABSTRACT

Penetration into the test room was studied by ragweed pollen introduced artificially into the air. Short-period sampling was found necessary in order to achieve an adequate degree of accuracy. More precise measurements of the density of pollen are being undertaken. A building has been placed in a field near the North Campus, and penetration measurements will continue there both before and during the 1955 ragweed season. The aerodynamic analysis is proceeding, and the first of a projected series of three papers is being prepared for publication.

OBJECT

The object of the research is to study both theoretically and experimentally (1) the dispersion of airborne particulates, and (2) the penetration of these particulates into structures as a function of atmospheric turbulence and wind velocity and direction.

I. INVESTIGATIONS BEING UNDERTAKEN AND PLANNED

A. EXPERIMENTATION DURING THE REPORT PERIOD

1. Artificial Bathing of Test Room with Ragweed Pollen.—Using the dry-atomization technique described in the last report, the test room in which all the 1954 measurements were made was bathed with ragweed pollen artificially. In this experiment the plume of pollen was traced by means of the arrays of coated slides (Fig. A, p. 2, last report), and the time variation of pollen concentrations inside the test room was observed by taking 6 volumetric samples in successive 3-minute intervals. The atomization technique provides a total time of emission of about 2 minutes. It is not surprising therefore that the 6 successive samples inside the test room (west window open, other openings closed) contained 94, 25, 12, 6, 1, and 1 pollen grains, respectively.

Slides from the array have been counted and the counts plotted on diagrams similar to those in the Appendix of the last report. They have not as yet been analyzed in detail.

The result of this test showed that the time period used for taking the first sample was too long, because it gives no means of judging at what time the maximum pollen concentration in the test house was achieved. A second test was attempted, therefore, using successive time periods of 1/2, 1/2, 1, 1, 3, and 3 minutes for the six volumetric samples. On this occasion a breakage of the atomizer occurred just after the start of the test. The atomizer was replaced and the experiment resumed, but the results were not satisfactory. The six samples contained, respectively, 0, 0, 7, 5, 4, and 2 pollen grains. These are considered insignificant, and the slides from the array (to trace the pollen plume) have therefore not been counted.

2. The Direct Measurement of Pollen Density.—A technique has been devised whereby the effect of the solution of pollen fractions in the immersion liquid can be reasonably well accounted for. This involves determinations of apparent pollen density by the use of increasingly concentrated solutions made from the pollen. The apparent densities found by this means

approach a limit which is taken as the true density figure. This experiment is nearly complete and will be separately reported in full.

3. Preparations for the 1955 Ragweed Pollen Season.—Following the suggestion of the Project Scientist, inquiry was made about a suitable building in which to conduct ventilation and penetration tests. These inquiries led to Mr. John Armstrong, president of the construction firm of Darin and Armstrong in Detroit. Mr. Armstrong has graciously offered the use of one of his firm's construction field office structures, delivered and set up on the project's site for use without charge. The building is conventional in design and construction except that it is mounted on skids and is apparently strengthened somewhat because of its movable nature. A complete description and photographs will be prepared for a future report.

A field site has been chosen in an open meadow on University property adjacent to the North Campus (about 3-1/2 to 4 miles from the Meteorological Laboratory) and the building has been placed there. It will be necessary to bring electricity about 1000 ft by cable from the field meter to the test site. Arrangements have been made to have a temporary meter connected for this project.

In order to get adequate time series of observations of pollen concentrations simultaneously, both inside and outside the test house, two sets of multiple sampling heads and associated timing and switching accessories are being designed.

B. EXPERIMENTATION PLANNED

1. The present plan is to conduct some experiments in bathing the new test house with an artificial shower of pollen, as soon as the field installation is completed. The scheme is to use three to five pollen atomizers distributed along a crosswind line some distance upwind from the test house, to distribute the coated slide arrays crosswind near the test house for the measurement of plume configuration and uniformity, and to make simultaneous sequential volumetric counts of pollen concentrations inside and outside the test house. In addition, the usual data on wind speed, direction, and general weather conditions will be recorded.
2. During the ragweed pollination season, observations of pollen concentrations inside and outside the test house will be collected on a full-scale basis. Ventilation and penetration rates will be found for the various weather situations encountered.

C. AERODYNAMIC ANALYSIS

The work undertaken in aerodynamics is mostly concerned with the preparation for publication of a paper on the statistical theory of turbulent dispersion of aerosol particles, in which part of the theoretical results of research conducted for this project will be reported. This paper is the first of three which will treat the problems of particle dispersion, impaction, and agglomeration in a turbulent fluid. The first paper will describe the general method of analysis which is used throughout the series. Particle dispersion in a homogeneous turbulent field is chosen as a typical problem which can be solved by this method.

The following is an abstract of the paper which is being prepared for publication.

"The mechanism of dispersion of aerosol particles which are suspended in a homogeneous turbulent field is considered. As compared to the classical theory of turbulent diffusion originally developed by G. I. Taylor, the discussion in this paper includes the inertia as well as the viscous fluid resistance effect of the particles on their dispersion. Generalized harmonic analysis is used in attacking the problem.

It is found that for a homogeneous isotropic turbulent field, particle dispersion depends on spectral density of turbulence and on a harmonic response function which relates a given sinusoidal fluid velocity to the particle velocity it excites. The dependency of particle dispersion on the eddy frequencies is considered, and it is found to be similar to that for turbulent diffusion except for a weighing factor which depends on the harmonic response function".

II. PERSONNEL, ADMINISTRATIVE, AND FISCAL INFORMATION

No personnel changes have occurred during the report period.

Actual expenditures up to the end of May, 1955 were approximately \$60,630 plus an incumbrance of \$280 for a total of \$60,910. The balance as of May 31 is approximately \$14,090.

A reconditioned Bausch and Lomb microscope with a graduated mechanical stage has been procured during the report period from the Monroe Micro-

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scope Service Company of Rochester, New York. Previously, all the project microscope work had been done with a binocular Leitz microscope which had been obtained on a personal loan basis. This instrument had to be returned, so it was necessary to find a reasonable replacement.

In making the purchase, three microscopes were examined on an approval basis, and this one was selected as the instrument best suited to our needs. The price was \$205.00.

