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Southern Research Institute



2000 NINTH AVENUE SOUTH
BIRMINGHAM 5, ALABAMA

November 7, 1962

AIR MAIL

Commanding Officer
U. S. Army Chemical
Research and Development Laboratories
Edgewood Arsenal, Maryland

Attention: Mr. Abraham Koblin
Contract Project Officer

Reference: Monthly Progress Report
Contract No. DA18-108-AMC-32-A

Dear Sir:

A design study was initiated during October to develop techniques and instrumentation concepts for measuring concentration of chemical agents as a function of time and the particle size distribution of the agents. The project has been organized in three phases:

- Phase I. Literature survey and orientation.
- Phase II. Investigation of means for sampling, determining particle size, and measuring concentration as a function of time.
- Phase III. Development of techniques and instrumentation concepts, including the evaluation of critical components.

Phase II will consist of a design study with some experimental work to evaluate the usefulness of various design concepts. The total time allowed for the first two phases is about four months. A more complete evaluation of the instrumentation concepts is planned for Phase III, which should last about five months. The report plan of the project will be to submit monthly progress letters and a comprehensive final report unless work on some particular problem merits a special engineering report.

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This progress letter summarizes the beginning of the literature survey and orientation of Phase I and gives plans for the project work during the month of November.

A table of physical properties of EX and VX has been compiled. Much of this information was made available by the Physiochemical Division of CRDL. This table provides enough information to make basic calculations on the behavior of a hypothetical cloud consisting of agent particles and vapor. Detailed information on particle size distribution in a VX agent cloud was not available at CRDL. From the table of physical properties we can calculate the behavior of a hypothetical cloud based on calculated forces that act on a particle. We have information for calculating most of the forces on the particle except thermal and electrical forces. For our present work on the behavior of the cloud the properties that we have should be adequate; however, we will continue to add to our list of physical properties to aid in our study of new detection schemes for chemical agents.

The chemical properties of VX and BZ are needed for work on the electro-chemical cell detectors. Most of the properties needed for the VX detector have been obtained and a CRDL report¹ on the chemistry of BZ will be ordered from STIA.

The toxicological properties of the agents and simulants are generally understood by all those working on the project. Knowledge of these properties is necessary to insure the safety of the personnel, high specificity of the detection system, and minimum interference from sampling and detecting the agents; but the toxicological properties or the effect of weather, air oxidation or explosive decomposition on the agents will not be studied at this laboratory. We will take advantage of all information available at CRDL to insure minimum effect on these properties by any proposed instrumentation concept.

We have reviewed the different methods of dissemination used now at CRDL as well as those planned for future work. For the purpose of our

¹CRDL Report No. 3088.

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study these questions have been asked about each dissemination method:

1. How much extraneous material is produced in the agent cloud?
2. How does the dissemination method affect the vapor-aerosol ratio in the cloud?
3. How is the content of the cloud affected by the ratio of the amount of agent to the amount of explosive or pyro-technic mix that is used for dissemination?
4. Do any of the dissemination methods planned for future work offer a large decrease in the amount of extraneous materials produced in a cloud?
5. What approximate concentrations and particle size distributions are present in a typical cloud?

Most of these questions, except No. 5, have been answered for explosive dissemination and for thermal dissemination of BZ. The questions on amount of extraneous material produced are important to our study because of the necessity to provide particle size distribution measurements with high specificity. Detailed information on dissemination efficiencies, the dose of agent encountered at different ranges, and the area covered by the cloud under different conditions has been studied and recorded.

The detailed information on dissemination methods and the information on the physical properties of the agent are classified and are recorded in the project file. Only the broad areas that we have considered are outlined in this letter and we hope that the review by the CRDL staff will disclose any important areas that we have failed to consider during our orientation.

A detailed study of sampling problems was initiated during October. It is hoped that new sampling methods and improved sampling efficiency will result from this basic work. No single sampling technique can cover the broad spectrum of particle size, 0.5 to 2000 microns diameter, needed for

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evaluation of chemical agents. For considering both sampling and detection methods we have divided the particle size spectrum into four bands of interest.

From about 0.5 micron to 10 microns, particles can be sampled by aspirating the aerosol through a short tube and detected by a light-scattering photometer. The instrument required should be very similar to those we have developed for previous work.

For particles between 10 microns and 100 microns, the settling velocity is too great for our present light-scattering photometer. To use a light-scattering photometer in this particle size range would require a shorter sampling tube with a larger diameter than used in our present photoelectric counter. The problem of diluting the input aerosol would also be more difficult than with the smaller diameter aerosol. The 10 to 100 micron band may be the most difficult band to sample because the particles settle too fast for sampling by aspirating them through a small tube, and yet they are so small that they are greatly affected by the wind. Perhaps a sample probe that is servoed to match the angles of azimuth, elevation, and velocity of the wind will provide a solution to this problem.

For the particle size range 100 to 2000 microns diameter, the inertia of the particles should be great enough to prevent normal atmospheric turbulence from disturbing the trajectory of the falling particles. The aerosol flash camera, which was described in the proposal, still seems to be the most feasible approach for particles in this size range. The flash camera may also be useful for the 10 to 100 micron diameter particles if the concentration is not too great at this size. The electronic flash camera was described in the proposal and only the main features are reviewed here. The droplets would be allowed to fall freely through the objective space of the camera and would be illuminated for a very short time by a sheet illuminator with a flash tube source. The objective lens would produce an image of the illuminated droplets on an image intensifier that would be turned on just slightly longer than the flash tube. The brightened image on the anode of the image intensifier will be relayed to a vidicon TV camera tube and the output signal of the vidicon will contain particle size information. The signal from the vidicon is amplified and processed to provide an electrical output

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that will give particle size and concentration information. In a feasibility study for the design of automatic counting and sizing instrumentation for the U. S. Naval Radiological Defense Laboratory, L. D. Miller² surveyed the possible techniques for counting and sizing irregularly shaped particles in the size range of 0.5 to 30.0 microns projected diameter. He recommended the use of flying spot scanner, but added that the use of a modified form of the conventional television camera would give more information for irregular particles. We believe that more detailed work may have been done by the Navy and by other workers mentioned in the references in Mr. Miller's article. During the design study of the electronic flash camera we will attempt to learn what has been done in this field since the report was written in 1956. The first experimental task of the project will probably be a breadboard test of the electronic flash camera. Much of the electronic equipment necessary for this test is available at the Institute and can probably be used for a preliminary evaluation of the flash camera scheme.

After the first month's orientation, which included two visits to CRDL and a cursory search of the literature, several factors appear important enough for special mention at this time.

1. To obtain high specificity, fluorescent tagging of the agents will probably be necessary for the photoelectric counting and the electronic flash camera.
2. The present concept of obtaining a large number of samples for a single test may be replaced by taking fewer samples with electronic instrumentation and conducting more tests. For example, it would seem that the accuracy and specificity of the particle size measurements could be increased by measuring the background of extraneous materials produced by dissemination without the agents.
3. Study of meteorology must assume an important place in the design of all sampling and particle size distribution instrumentation.

²USNRDL Report No. TR-134, 16 November, 1956,
USNRDL, San Francisco, California.

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4. Particle size distribution of BZ will be more difficult to measure with photoelectric techniques than VX due to the presence of more extraneous material during a typical BZ dissemination. However, an idea of the particle size distribution can be obtained from the measurements of MMD that can be made at CRDL.
5. From No. 4 it would seem that the primary application of the particle size distribution instruments, especially the flash camera, would be in the study of VX.

During the month of November the study of sampling will be continued with particular emphasis on the effect of meteorology on cloud behavior and sampling. This study is being conducted by Norman Francis, Research Engineer. The design study of the electronic flash camera will also be started next month by Robert Collins, Electronic Engineer. Work must be started to improve the sensitivity of the electro-chemical cell and provide a concentration readout as a function of time. The study of adapting the electro-chemical cell for the detection of BZ will be continued during November under the direction of W. J. Barrett, Head of the Analytical Chemistry Section. The survey of the literature will continue throughout the second phase of the project and will include a study of sampling methods for particles larger than 10 microns in diameter, detection methods for all particle sizes that will produce high specificity, and a continuing study of the physical and chemical properties of the chemical agents of interest.

Yours very truly,

Alvin N. Bird, Jr.
Alvin N. Bird, Jr.
Research Physicist
Instrument Development Section

Approved:

Sabert Oglesby, Jr.
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