DRAFT: 6/3/81

PROJECT CONCEPT MEMORANDUM

Diffusive Sampling Methods Development

Division: DPSE
Proposed Project Director: George A. Carson, Ph.D.

1. Description of Proposed Project

An entirely new concept in personal monitoring (passive monitors), relying on the physical properties of diffusion and permeation, has the potential to produce personal exposure data for a variety of volatile toxic substances. These passive monitoring devices offer several advantages over traditional sampling methods including eliminating the sampling pumps (and their associated errors), eliminating the use of liquid-filled glass bubblers (and their breakage, spillage and storage problems), and have significantly improved wearer acceptance increasing the likelihood of conducting a successful monitoring program.

Since passive monitoring was introduced into industrial hygiene practice, DPSE, DSHEFS and DRDS have conducted a small number of independent studies in this area, including an evaluation under contract to UBTL of three passive organic vapor monitors. Of great importance is the significant growth that has taken place in this field. In 1972, there were two manufacturers of these devices. Today, thirteen companies manufacture passive monitors and several additional companies are planning to market passive monitors in the next year. These devices come in a variety of forms, ranging from small clip-on badges to pocket-size electronic integrating and alarm devices. They sample by one of a variety of mass transport phenomena, may be general monitors or substance specific, and are analyzed via one of a variety of techniques. As a result of increased demand, a real need has arisen to understand how these passive monitors work, to understand under which environmental conditions they will accurately reflect a worker's exposure, and to understand how they may affect sampling strategies. NIOSH has a responsibility to develop technical expertise in this area, including recommendations for performance specifications and testing protocols.

The work to be performed under this project is divided into three areas. The first is fundamental research with the goal of increasing our understanding of the physical chemistry of air sampling devices operating by the mechanisms of diffusion and permeation. Such understanding is the basis for effective usage of these types of devices. The second area is the definition of the performance specifications to be used as a reference for future development and validation of methods using diffusive sampling devices. Method development and validation is the third area.

Fundamental Research. A fundamental study of the relationship of contaminant adsorption isotherms and the diffusive flux will be performed. The adsorption isotherms of selected model compounds for several collection elements, under dry and humid conditions and in the presence of more strongly adsorbed species, will be obtained. These will be correlated with the behavior of the diffusive samplers operating in normal fashion. A good correlation should lead to a mathematical model which will allow prediction of the usable range of a diffusive sampler for untested contaminants based upon the isotherms of these contaminants for the collection media.

The purpose for this research arises from problems associated with the use of diffusion samplers containing an adsorbent as the collection medium. A considerable portion of the data obtained on the behavior of such samplers shows that the diffusive flux, that property of the diffusive sampler which defines the rate of diffusion of material to the collection medium, is not properly described by the simplified equation usually derived from Fick's first law of diffusion. One of the assumptions on which the simplified equation is based is that the adsorption isotherm, for a contaminant, has no effect on the diffusive flux. For the less strongly adsorbed contaminants (such as vinyl chloride and acetone), in the situation where the relative humidity of the workplace air is high, or in situations where the fluctuations in contaminant concentration over the sampling period are large, this assumption is most likely incorrect, and the measured concentrations are likely to be lower than the true values.

Performance specifications. Performance specifications will be defined for use as reference for future method development and validation and in establishing quality assurance programs. In order to use an air sampling and analytical method with confidence, certain critical parameters of the method must be known or determined. With such data the user can appreciate the capabilities and limitations of the method. For methods employing diffusive sampling, these data include precision, accuracy, useful range, interferences, sample stability, and restrictions on sampler use (such as minimum face velocity). Of special interest is accurate determination of the diffusive flux (or, more loosely speaking, sampling rate) and the time-concentration range over which it is constant.

Method development and validation. We will perform such evaluations as are consistent with the programatic needs of the Institute. Additionally, methods using diffusive samplers will be developed for several volatile organic amines and the inorganic gases ammonia, sulfur dioxide, hydrogen cyanide, and hydrogen sulfide. (Methods for the inorganic gases were requested by OSHA through the NIOSH Planning Group.) These methods will, in the laboratory and field, be thoroughly evaluated using the protocol developed with the guidance of the performance specifications.

2. Relationship of the Project to Identified Institute Priorities

One of the primary strengths of this project is its relationship to other projects within the Division and the Institute. The results of this project will be a source of information useful to DSHEFS (IWSB and HETAB), DRDS and DPSE. Specific needs of OSHA will be satisfied through this project, in addition to interests of MSHA and EPA.

3. Value of the Project

A great deal of the value of this project is rooted in the needs of the industrial hygiene community. Specifically, use of passive monitors -- which have documented increased wearer acceptance -- will increase the probability of conducting successful monitoring programs. This is particularly significant when the monitoring programs concern toxicologically important compounds such as glycol ethers.

This activity will also benefit the Institute by providing a data bank, performance recommendations, and testing protocols which will save countless person-hours and dollars by allowing much testing to be performed in the private sector.

4. Rationale for the Approach

This project will be undertaken directly by in-house personnel using in-house facilities over a three-year period. The exposure chamber constructed for an FY81 project will be used to generate test atmospheres. This chamber has the proper controls for the test conditions addressed in the scope of work. A second chamber will be constructed to accommodate some of the work using in-house personnel.

5. Facilities Required

Approximately 800 sq. ft. of office space and 1000 sq. ft. of laboratory space is required. The exposure chamber designed and built for the N_2O monitor evaluation will be used in the laboratory along with an ion-chromatograph, UV-VIS spectrometer, IR spectrometer, and gas chromatographs for the exposure and analysis of the monitors.

6. Estimated Time of Performance and Estimated Costs

This work should be completed in three years with a cost estimate (excluding personnel costs) of $200,000.

Items	Estimated Expenditures (FY82, 83, & 84)
Intramural Costs	
Training	2000
Conferences	1000
Travel	11000
Adsorption isotherm apparatus	58000
Equipment less than $1000	30000
Passive monitors	40000
NH_3 monitor	5000
Supplies	40000
IC detector	5000
Service & supplies BPA for IC	8000
TOTAL:	200,000

7. Competitive vs. Non-Competitive Procurement

Sole source procurement from each of the commercial suppliers of diffusive samplers is required to obtain the necessary monitors for evaluation.

8. Full-Time Equivalents

	PY (3 ears)
Professional	10.0
Technician	2.5
Management/overhead	2.5
TOTAL:	15.0

9. Federal and Non-Federal Reviewers

Mr. Mel Cassidy, OSHA, Salt Lake City
Mr. Jim Perkins, UBTL, Salt Lake City
Mr. Dick Thompson, University of Alabama

10. Clearances Required

None