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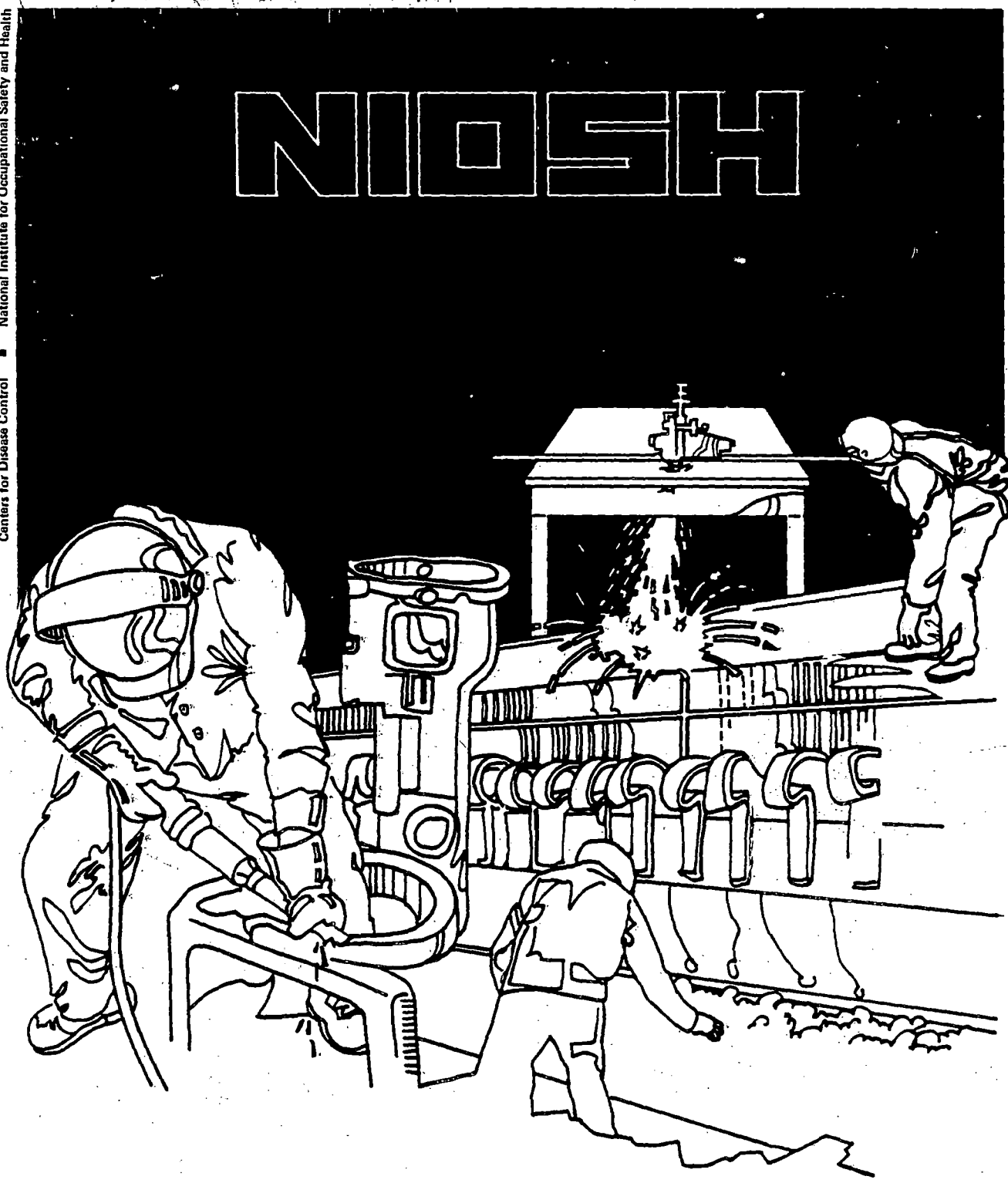

Health Hazard Evaluation Report

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CINCINNATI, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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I. SUMMARY

On February 9, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from Local 3840 of the American Federation of Government Employees at the NIOSH Robert A. Taft Laboratories, Cincinnati, Ohio.

The request was for an assessment of potential health hazards associated with the laboratory and animal facilities. There was specific mention of potential exposures to MOCA, benzene, radiation, formaldehyde, solvents, acid, incinerator emissions, and concern about animal cage washing procedures and the ventilation system.

Based on the observations made during the initial walk-through evaluation on February 20, 1981, and the results of the questionnaires completed for 38 laboratory/activity areas, three airborne exposure surveys were conducted in the Autopsy Room, Tissue Preparation Room, and Clinical Chemistry Labs. In addition, the 25 lab fume hoods and numerous other local exhaust systems were evaluated. The investigators conducted observations and interviewed workers in most of the labs and reviewed the occupational health program.

An environmental survey of the Autopsy Room and the Tissue Preparation Room was conducted on June 11. The formaldehyde exposure levels were all below the limits of detection of the Drager tube (0.6 mg/m^3). Time-weighted average formaldehyde exposures ranged from 0.08 mg/m^3 to 0.18 mg/m^3 for the Autopsy Room workers. Personal breathing zone formaldehyde levels were 0.43 and 0.56 for Tissue Preparation Room workers. Xylene exposures were 0.57 and 0.21 mg/m^3 and ethanol exposures were 1.95 and 2.08 mg/m^3 for the two workers. Exposures to benzene, hexane, and acetone in clinical chemistry were measured on September 10, during demonstration of two typical uses of these materials. The personal breathing zone exposure levels for benzene were 2.7 and 0.66 mg/m^3 with room area levels ranging from 0.09 to 0.12 mg/m^3.

The 25 performance evaluations of fume hood were conducted September 9-11 in accordance with the EPA criteria. There were only 3 hoods which received both ideal ratings and 7 hoods which received only ideal and good ratings. The remainder were rated poor in one or more performance criteria. This evaluation also revealed that a general ventilation survey to provide a balanced system and effective hood performance is needed.

There is a need for improved hazardous material management system - inventory control of procurement, storage, handling, and disposal. Also, a physician should be designated to act as consultant to the DBBS Safety Committee. The committee, in conjunction with this medical consultant, should review present policies and procedures concerning the DBBS occupational health program and establish clear written policies regarding the medical surveillance and immunization requirements for DBBS employees.

Worker's exposures to benzene (in the clinical chemistry lab) and to formaldehyde (in the autopsy room and tissue preparation rooms) were not at the lowest feasible level as recommended for carcinogens. Recent changes in these areas have provided better control measures, but further modifications are needed. Also there is a need for improvements in the hazardous materials management system. Recommendations are contained in Section VII.

KEYWORDS: SIC 8922 (Research Laboratories), benzene, MOCA, ventilation, formaldehyde.

II. INTRODUCTION

On February 9, 1981, the National Institute for Occupational Safety and Health (NIOSH) was requested by Local 3840 of the American Federation of Government Employees, Cincinnati, Ohio, to perform an evaluation of potential occupational health hazards at the NIOSH Taft Laboratories. Specific reference was made regarding exposures to MOCA, benzene, radiation, formaldehyde, solvents, acids, and incinerator emissions; potential problems with cage washing activities; and possibly inadequate exhaust ventilation hoods.

NIOSH provided a status report on March 11, 1981, outlining the activities investigators planned to accomplish as part of the overall evaluation. The results of personal exposure monitoring in the Autopsy Room and Tissue Preparation Room were transmitted in a letter of August 31, 1981. The results of personal exposure monitoring in the Clinical Chemistry Laboratory were transmitted in a memo of March 8, 1982.

III. BACKGROUND

The Taft Laboratories are located in a 7-floor research facility covering 90,000 square feet and are operated by the National Institute for Occupational Safety and Health. Activities in this facility include administrative, technical services, training, and laboratory research. There are three NIOSH divisions [Division of Biomedical and Behavioral Science (DBBS), Division of Training and Manpower Development (DTMD), and Division of Standards Development and Technology Transfer (DSDTT)] and our administrative offices located at Taft. NIOSH has approximately 50 administrative and 220 Division employees working in the building. In addition, the Food and Drug Administration Bacterial Physiology Branch Laboratories occupies half of the third floor. This group studies foodborne diseases and employs 13 researchers in the facility. The only NIOSH employees that routinely work directly with toxic substances or hazardous physical agents while in the Taft facility are the 80 DBBS research workers. The DBBS facilities included laboratories for biological, chemical, ergonomic, physical sciences, behavioral, and toxicological research, as well as areas for animal exposure chambers and housing.

On February 20, 1981, the survey was initiated with a walk-through to orient the NIOSH team on the work areas and activities. Questionnaires were provided to be filled out on each research activity/area. The information requested was to aid in assessing the nature of the various activities, including potential health hazards and control measures.

On March 2, 1981, a separate meeting was held with FDA laboratory management and safety representatives. A brief tour of their laboratory area was conducted.

On March 6, 1981, a meeting was held with management and union representatives to discuss the plan for the evaluation of anticipated upcoming activities and controls. Participants were asked to identify on the questionnaires any events of interest planned for the coming months.

On March 5 and 11, 1981, the MOCA handling procedures and rat gavage dosing procedure were reviewed and observed.

On April 7, 1981, the overall facility ventilation system was discussed with the facility engineer and a walk-through was accomplished with emphasis on the animal exposure chamber ventilation and monitoring systems and operating procedures.

On May 7, 1981, the completed activity survey questionnaires were received identifying 38 activities and/or activity areas in the facility. Based on the survey questionnaires and observation of the investigators, several activities were selected for personal exposure monitoring and for further observation.

On June 11, 1981, personal exposure monitoring was conducted in the Autopsy Room and Tissue Preparation Room during the sacrifice of rats in the ongoing ethylene oxide exposure study.

On September 9 and 11, 1981, follow-up observations in selected laboratories and the initial walk-through of the Physical Agents Branch Laboratories were conducted.

On September 10, 1981, personal and area exposure monitoring were conducted in the Clinical Chemistry Laboratory during benzene handling procedures. On the same date, the incinerator was observed in use disposing of biological waste.

During the week of September 14, 1981, a performance evaluation survey of all NIOSH Laboratory hoods and associated local exhaust systems in the Taft facility was conducted. The data from this survey were reduced and analyzed during the later part of January 1982.

IV. EVALUATION DESIGN AND METHODS

A. Objectives and Strategy

It is beyond the scope of this survey to fully assess each research program and activity area. Such a health and safety assessment must be an ongoing part of a dynamic research activity such as the one in this facility. One of the objectives of this survey is to heighten awareness of this need and to focus attention on areas where improvements can be made.

The objectives and strategy of the health hazard evaluation were stated in the opening conference and in the planning meeting of March 6. It was further agreed that since this facility was in Cincinnati and a part of the investigating agency it could receive a more extended evaluation than would normally be possible. This would provide more specific technical guidance in selected areas.

A questionnaire was self-administered by requesting that management and union work together in identifying the activity areas and soliciting completion of a three-page survey form in each activity/area. This form is routinely applied to industrial Health Hazard Evaluation surveys to collect information on worker profiles and demographic data; types of work activity and recent changes; types, quantity, and frequency of substances utilization; and exposure controls including ventilation, personal protective equipment, and administrative. An additional request was made for a schedule of significant events in the coming months.

Prior to completion of the survey forms the initial survey activities were directed at the major areas of concern raised by the union (i.e., DBBS' MOCA study, the animal exposure chambers and husbundry areas, animal autopsy and tissue preparation activities, and the general facility ventilation). The occupational health physical examination program and the general structure of the health and safety program also were reviewed.

The survey questionnaires identified 38 research activities or areas many of which required further study. These laboratories were revisited and research activities were discussed with the workers to gain a better understanding of the potential health hazards and control measures involved in each activity. Much of the discussion in this report is based on these observations and discussions.

Three areas were identified for environmental exposure measurements. The use of benzene in the clinical laboratory was selected as an activity of concern that required measurements to assess the effectiveness of the ventilation controls. Two frequently performed procedures, cleaning of glassware and MOCA column cleanup, were evaluated. The Autopsy Room and Tissue Preparation Room were selected to conduct environmental exposure measurements during the next major animal sacrifice, scheduled for June and later rescheduled for July.

The effectiveness of laboratory hoods and other local exhaust control systems were of concern to many of the workers. There were 25 laboratory fume hoods identified in NIOSH laboratories and numerous siphons, canopies, exhaust tables, and special purpose local exhaust slots. The number of uses and applications of these hoods varies from day to day and project to project. Therefore, an

evaluation of the adequacy of each hood for the procedures past, present, or proposed would be beyond the scope of this survey.

The benefit derived from a general survey of the performance of each of these hoods would have required a considerable expenditure of effort. The findings of this performance evaluation are limited to an assessment based on the EPA Laboratory Hood Performance Evaluation Criteria.[1]

The immediate objective of this hood performance evaluation effort was to heighten the workers awareness of the individual hood's limitations and the beneficial or adverse effect that work practices and environmental variables can have on the effectiveness of the hood's intended control function. To this end, the individual surveys were conducted, whenever possible, with the users present. As necessary, the limitations in operating conditions such as maximum sash height to provide acceptable face velocities and a capture pattern free from excessive air turbulence were demonstrated and marked. The effects of pedestrian traffic, opening and closing of nearby doors, workers movements, positioning of apparatus in the hood, and return air currents across the face of the hood were discussed.

The long-term objective of the hood performance evaluation is the development of a capability to assess the adequacy of each hood for a present or planned hood application. This will aid in prioritizing the need for facility improvements. It will aid in judging the adequacy of interim work practice measures and use of personal protective equipment. Selection of the appropriate hood for the task will ensure the most effective utilization of the laboratories hood control systems. To be fully implemented, this evaluation must be extended beyond the scope of the HHE to include ventilation system performance parameters from the building engineers files and permissible interim sash operating heights should be formally posted.

B. Environmental

1. Autopsy Room No. B-2

Airborne formaldehyde samples were collected in the breathing zone of Autopsy Room workers on impregnated charcoal tubes using DuPont P4000 sampling pumps at a flow rate of 500 cc/min. The sampling period was for the full term of the activity, about 4 hours.

2. Tissue Preparation Room No. B-4

Airborne formaldehyde, xylene, and ethanol samples were collected in the breathing zone of the Tissue Preparation Room

workers. Low-flow Sipin pumps were run at 200 cc/min for the full term of the activity, about 8 hours. Formaldehyde was collected on impregnated charcoal tube and the others on standard charcoal tubes.

3. Clinical Laboratory Room No. 301

Airborne benzene, hexane, and acetone samples were collected in the breathing zone of the laboratory worker conducting the procedure, and area samples at the two desks located in the clinical laboratory. Samples were collected using either a two or a three-tube manifold with a MSA model G personal monitoring pump. Each tube's flow rate was controlled by an individual critical orifice. Each three-tube manifold had one 100 cc/min and two 50 cc/min orifices. The two-tube manifold's orifices were both around 100 cc/min. Three-tubes had originally been required in order to provide a sample for analysis of ethyl acetate, however, it was found that this compound was not used in the portion of the MOCA extraction procedure monitored.

The local exhaust ventilation measurements were taken with a Kurz Model 441 constant temperature thermal anemometer. Readings were corrected for post-survey calibration check results. Results are reported as linear feet per minute (LFPM).

Smoke tube observations were made using Bendix tubes.

Peak exposure levels were measured with Drager detector tubes with lower limits of detection as follows:

Benzene 5/b - 5.0 ppm
Benzene 0.5/a - 0.5 ppm
n-Hexane 100/a - 50.0 ppm

C. Analytical

Formaldehyde samples were analyzed via ion chromatography on a Dionex Model 10 ion chromatograph. NIOSH Method P&CAM 318[2] was followed with minor variations in the preparation and analysis of samples. To effect separation of the formaldehyde peak from neighboring signals, 0.0025M. borate eluent was employed. Columns used were 4x50 mm anion precolumn/concentrator, 4x250 mm anion separator, and a 10x100 mm anion suppressor. Under these operating conditions, a retention time of 6 minutes was observable for the formate ion. Media blanks were run and corrections made. Field blanks were below the lower detection limit of 6.0 micrograms per sample for this data.

Xylene and ethanol samples were analyzed according to NIOSH Method No. S-56[3] (modified), using a Hewlett-Packard 5731A gas chromatograph with a flame ionization detector. The samples were separated into front and back portions and desorbed in 1 mL of carbon disulfide containing 1 ul/mL toluene as internal standard and 1% 2-butanol as an acid in desorption. Field blanks were less than the limits of detection for this data of 0.01 mg for xylene and 0.01 mg for ethanol per sample tube.

Benzene, acetone, and hexane samples were analyzed according to NIOSH Method No. P&CAM 127[3] (modified), using a Hewlett-Packard 5731A gas chromatograph with a flame ionization detector. The samples were separated into front and back portions and desorbed in 1 mL of carbon disulfide using an external standard method. The field blanks were less than the lower detection limit for this data of 0.001 mg/sample for benzene, 0.03 mg/sample for acetone, and 0.01 mg/sample for hexane.

D. Medical

The NIOSH occupational medical records of 50 randomly selected Taft NIOSH employees and the medical records of the eight animal husbandry personnel were screened by the medical officer. He participated in all of the observations of laboratory activities, except those dedicated to environmental measurements, to assess the adequacy of the occupational medical program. During the observation of lab activities, informal interviews regarding the health concerns of many of the research workers were conducted. More formal interviews were conducted with the eight employees engaged in animal care activities in the animal care quarters and exposure chamber areas.

V. EVALUATION CRITERIA

A. Toxicity

Criteria for limiting occupational exposures to toxic chemicals and physical agents considered in the evaluation include: the legal standards of Occupational Safety and Health Administration (OSHA); the National Institute for Occupational Safety and Health (NIOSH) recommended standards; and the American Conference of Governmental Industrial Hygienists Threshold Limit Values®. These criteria are presented for the substances evaluated in this report in Appendix I along with the primary health effects.

1. Benzene

Benzene can cause central nervous system (CNS) depression and chronic exposure can result in depression of the hematopoietic system. Because of an increased risk of leukemia in benzene

exposed workers (benzene is considered by NIOSH to be carcinogenic in man), NIOSH recommends a standard of 3.2 mg/m^3, as a 60-minute ceiling.[4,5,6]

2. Xylene

Xylene can effect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin. Short-term exposure to xylene vapors may cause irritation of the eyes, nose, and throat. At high concentrations, xylene vapor may cause severe breathing difficulties which may be delayed in onset. It may also cause dizziness, staggering, drowsiness, loss of appetite, nausea, vomiting, abdominal pain, and unconsciousness.[9] The xylene exposure limit recommended by the ACGIH and NIOSH is 435 mg/m^3 [100 ppm] for an 8 to 10 hour work shift.[7,8] The ACGIH STEL is 655 mg/m^3 [150 ppm], NIOSH also recommends a ceiling limit of 870 mg/m^3 [200 ppm].

3. Formaldehyde

Formaldehyde is an irritating substance that can cause respiratory, mucous membrane, and skin irritation as well as sensitization dermatitis. Since recent studies have found that formaldehyde is carcinogenic in rodents, NIOSH recommends that formaldehyde should be handled in the work place as a potential occupational carcinogen. Safe levels of carcinogens have not been demonstrated but the probability of developing cancer should be reduced by decreasing exposure; therefore, it is prudent to reduce exposure to the lowest feasible limit.[10] The first signs of exposure to formaldehyde at concentrations ranging from 0.1 to 5.0 ppm are burning of the eyes, tearing, and general irritation of the upper respiratory passage. Higher exposures of 10 to 20 ppm may produce coughing, tightening of the chest, a sense of pressure in the head, and palpitation of the heart. Exposures to 50 to 100 ppm and above can cause serious injury such as collection of fluid in the lungs, inflammation of the lungs, or death. Dermatitis is a well-recognized problem. After a few days of exposure, a worker may develop a sudden inflammatory reaction of the skin of the eyelids, face, neck, scrotum, and flexor surfaces of the arms. An eczematous reaction may also appear on the fingers, back of the hands, wrists, forearms, and parts of the body that are exposed to the rubbing of clothing. This sometimes occurs after years of repeated exposure.[10] The OSHA Permissible Exposure Limit for formaldehyde is 3 ppm, 8-hour TWA, and 10 ppm as a maximum ceiling concentration.

B. Fume Hood Performance Criteria

The evaluation method was devised under contract by the EPA[1] and has been reviewed by OSHA Director of Technical Support. This review found the EPA Laboratory Fume Hood Standard to be a well-prepared document which provides very good guidelines on the design, construction, operation, maintenance, and evaluation of fume hoods. The EPA procedure is referenced in the National Research Council's (NRC) publication "Prudent Practices for Handling Hazardous Chemicals in Laboratories"[11] and is part of the NIOSH curriculum for ventilation instruction in Course No. 588. The cursory analysis of hood performance based on average face velocity alone is not adequate to evaluate the effectiveness of fume hood systems. The importance of other environmental factors is recognized in the previous published guides from ACGIH and NIOSH.[12,13] The EPA criteria has provided a means of evaluating these other factors. This criteria is expressed in terms of poor, good, or ideal room factors, and hood locations. Also smoke tube flow pattern observations, face velocity averages and variability at full open and six-inch sash heights.

A hood cannot be considered satisfactory if it has a poor rating for either the room factor or location. The six-inch face velocity should be less than three times the full open average face velocity. The variablility of the full open face velocity from the average should not exceed (+)10 fpm. The appropriate face velocity depends on what is required to maintain effective capture and smooth flow in the room environment for the procedure used. The cross drafts at the face of the hood should not exceed 25 fpm. The ideal location and room ratings will usually require around 80 fpm average face velocity with a full open sash to establish smooth airflow patterns and effective capture. With good ratings, the flow should be raised to 100 fpm average. It is not recommended that flows be increased above this level to compensate for poor environmental factors. The higher flow rates will result in increased turbulence in the hood resulting in greater risk of dragout at the hood face. In any case, it is impractical to raise them high enough to overcome poor work practices, blockage by storage containers or equipment, cross current effects from pedestrian traffic or improperly directed supply air. Face velocities over 350 fpm are disruptive to procedures which require handling of powdery and light-weight materials. For a more detailed discussion, see Appendix 2.

C. Noise Criteria

NIOSH recommends that employee exposure to noise in the work place be controlled so that no worker is exposed in excess of the limits presented below:

Exposure Duration	Sound Level (dBA)
8 hours	85
4 hours	90
2 hours	95
1 hour	100
0.5 hour	105
0.25 hour	110

At no time should workers be exposed to noise levels exceeding 115 dBA. These limits are designed to protect most workers from noise-induced hearing loss that could impair their abilities to understand everyday speech.[14]

The General Radio Handbook of Noise Measurement[15] provides a detailed guide for analysis of Speech Interference Levels. This criteria is based on the average sound pressure level in the 500, 1000, and 2000 cycle bands which would be the predominant interferring frequencies for normal speech.

The American Society of Heating Refrigerating and Air-Conditioning publish criteria for design of air-conditioning systems. These criteria include goals for noise control. The ASHRAE Guide and Data Handbook 1965 and 1966[16], Chapter 14, Table 4, provides a recommended design range for prevention of speach interference.

D. Laser Criteria

Laser criteria were taken from ANSI Standards Z136.1-1980.[17]

E. Medical Surveillance Criteria

The criteria used for evaluating the health protection and health monitoring procedures for the Taft employees were derived from several sources. The major source was the CDC Lab Safety Manual[18] (1979). Recommendations for the occupational health needs of animal care workers and for the proper procedures and equipment for animal housing and care were derived from the Guide for the Care and Use of Laboratory Animals prepared by the National Research Council[19] (1978), as well as the CDC Lab Safety Manual. Phone consultation with the CDC Veterinarian Branch and the CDC Office of Biosafety was obtained to clarify how these guidelines might relate to the specific conditions existing at the Taft Laboratory. For specific chemical exposures (benzene, formaldehyde, etc.), NIOSH and other published documents were used.[4,5,6,7,8,9,10] For laser exposure, American National Standard for the Safe Use of Lasers (ANSI Z136.1-1980)[17] was used.

VI. RESULTS AND DISCUSSION

A. General Observations

There was an overall impression that was conveyed by the discussion held in both private and public meetings that improvements were needed in the Taft Laboratories health and safety program. The NIOSH Safety Office is aware of many needed improvements, both in the facility and in the management approach to safety in the research environment. With this general agreement that improvements were needed, DBBS, the division engaged in laboratory research activities had already established a safety committee. Many of the topics discussed in this report were already under review within the committee and this committees activities have continued throughout the course of this evaluation.

In a research-oriented organization with a diversified group of research activities, there must be a strong awareness of the overriding need for safety and health. It is often true in laboratories that the researchers are working on the frontiers of knowledge in their field. Many times, the toxicity of the materials under study is the question being explored. The primary researcher is among the most knowlegable in the field on the potential hazards in his area of expertise. It is necessary to accommodate flexibility from day to day if creative research is to be accomplished. However, along with that freedom comes increased responsibility for the individual researchers. They must carry a much greater burden of responsibility for the safety of their co-workers than do those in other laboratories in a more routine and predictable production-oriented environment. To a great extent, management's emphasis on this role of the primary investigator is the key to an effective program.

There was a new DBBS procedure established to provide training and operating procedures for research projects. The primary investigator is responsible for submitting a protocol for his project and in addition a chemical hazards information/instruction document. This document outlines the nature of the hazard for each substance and the instruction must be signed by and a copy given to each worker potentially exposed. This approach of fully informing each individual should be encouraged throughout the laboratories.

B. Surveillance

The Safety Office in a research environment is often more effective as a consultative service to those who are seeking assistance in evaluation or control of potential hazards, which they perceive in their activities. However, there is always a need for inspection and surveillance to identify other hazards and to maintain the focus on this overall effort within the organization.

In this regard, there is an apparent need to increase Taft Laboratories surveillance in three ways. First is the need to monitor changing protocols in ongoing research activities. The DBBS quality assurance program which has recently been implemented could require a periodic safety review as part of the routine project review cycle. This approach may prove to be an effective tool to monitor the changing character of potentially hazardous reseach activities.

Second is the need for an inventory control on the procurement, storage, handling, and disposal of hazardous materials. This was a topic of discussion at our March 1981 planning meeting and of interest to the investigators throughout the survey. There are at least two approaches to this objective. One is to channel all hazardous material's purchase requests through one central authority. While this sounds simple it is not easy to establish a procedure which ensures that all hazardous material's requisitions are identified for this type of handling. This problem is further complicated since there is no central commisary or pharmacy to control the storage and issue of the materials after receipt in the facility.

One alternative is to place the responsibility with each subordinate group to keep a control inventory on all hazardous materials and inform the Safety Office of new purchases and submit handling, storage, emergency, and waste disposal procedures for safety review and approval. In either case, a role of the surveillance program must be a periodic inventory check to assure that the materials are being utilized and disposed of in accordance with approved procedures. Discussion of this activity is found in Reference Nos. 11, 20, & 21. A draft EPA regulation for Use of Toxic Materials in Laboratories presents one approach to inventory control which combines the two methods mentioned above.[22] The system used to accomplish this task at Taft Laboratories must be developed by those most familiar with the research role of the agency and the activities of the individual research groups. The DBBS Safety Committee and the NIOSH Safety Officer should continue to work toward implementing such a system.

Third is the need for a formal environmental monitoring schedule to provide periodic measurements of hood performance and personal exposures. The EPA Fume Hood Performance Criteria requires monitoring at least every 6 months.[1] The selections of activities to monitor and the frequency of monitoring must be based on professional judgment. There is generally a need to evaluate new or changing environmental conditions. This is discussed in the same references cited above.[11,20,21,22]

C. Engineering Controls

1. General Ventilation

A complete evaluation of the general ventilation is beyond the scope of this survey. The existing ventilation system has been extensively modified by capping supply air ducts and relocating laboratory hoods. The ventilation blue prints are out of date. Even the drawings of more recent additions were not as built. The maintenance contractors reported that efforts were made several years ago to measure airflows in some of the ducts. Fans were adjusted to increase replacement airflow. In the winter, they sometimes use the old hood replacement air fans and ducts to provide supplemental replacement air to the building. This system has limited heating capability, but no cooling, so it is not used in the summer months or during extreme cold weather. A number of observations can be made which indicate the need for correction of ventilation problems. It was observed that the laboratories are not always under negative pressure with respect to the surrounding hallways. Since most of the hoods do not have separate makeup air provided, it is likely that the pressure relationship will vary with the operation of heating, air-conditioning, and local exhaust systems. This is particularly true if more than one local exhaust is connected to the same fan. This overall air balance will have a direct impact on the effectiveness of ventilation controls such as storage cabinets, fume hoods, and other local exhaust systems. Several air balance deficiencies were noted in the course of the ventilation survey, which are documented in the Hood Performance Evaluation Appendix. On the basis of these observations, there is a need for a comprehensive evaluation of the ventilation system.

Reference No. 11 recommends that in all cases, the movement of air in the general ventilation system for a building should be from offices, corridors, and such into the laboratories. All air from laboratories should be exhausted outdoors and not recycled. Thus the air pressure in the laboratories should always be negative with respect to the rest of the building. The air intake should be in a location that reduces the possibility of contamination from exhaust air.

2. Fume Hood Performance Evaluation

The Laboratory Fume Hood Performance Evaluation for each hood and the surrounding local exhaust systems are documented in Appendix 2. The Taft Laboratory hood evaluated by the EPA criteria[1] were found to be deficient with only a few exceptions. The multiple deficiencies were insufficient full

open average face velocities, lack of bypass air, poor room factors resulting from excessive cross drafting, and poor hood location ratings due to traffic patterns and door and window locations. A summary rating table is provided in the Appendix, however, the interaction of the rating factors requires a case-by-case assessment to fully appreciate the rating given. The causes of these deficiencies are related to the overall building ventilation system as well as the individual local exhaust system and its immediate surroundings. There were two deficiencies which were found throughout the survey. Very few units were equipped with either an airflow indicator or adequate air bypass capability. Without this capability, the face velocity far exceeded the maximum recommended criterion of three times the average as the sash was lowered to a height of 6 inches.

To provide a prospective on these findings and to verify the proper application of the criteria the EPA Safety Office was consulted. They confirmed the evaluation method used and reported similar results when first applying these criteria to their own facilities. The EPA has undertaken an extensive remedial program in their 24 laboratories to upgrade their 700 fume hood control systems and the integral general ventilation systems. For details of their program and consultation on various remedial methods, NIOSH should contact the EPA Headquarters Engineering Coordinator.

3. Miscellaneous Local Exhaust Systems

The other local exhaust systems observed in the same room with laboratory fume hoods were given a cursory performance evaluation. The results are reported on the same sheet with the Fume Hood Analysis. The performance requirements of these systems would be dependent on the operating procedures and conditions of use. In some cases, there was an obvious lack of control velocity or smoke tube capture at the apparent point of application, which was noted in the evaluation.

4. Animal Exposure Ventilation

The high hazard exposure area was under major renovation during the survey and not operational. The acute exposure chamber systems were not operating during the periods of observation. The chronic animal exposure chamber ventilation system was observed in operation. These ventilation systems were reviewed with the facility engineer. The exposure generating chambers were exhausted as were the animal exposure chambers through charcoal filters to the outside. Incoming air is filtered. Operating procedures for the changing of charcoal filters were discussed but not observed. The

location of the filter change area is in cramped overhead crawlway which raises concern for difficulty of access and handling procedures. The need for a method to assess the filter system performance and saturation limits was discussed with the facility engineer. It was noted that a study had been proposed to evaluate the breakthrough potential for contaminants. However, this was considered to be of limited value since it might vary with substances and with operating conditions. Therefore, a periodic monitoring of the absorption capacity of the filters is called for in the operating procedure. Methods of accomplishing this are not readily available. There is an ongoing research project in this area reported by P.M. Swearengen, Lawrence Livermore National Laboratories, Livermore, California, at the 1982 American Industrial Hygiene Conference (Paper No. 70). In practice the filter breakthrough surveillance has been accomplished by placing one of the multiple fixed point sampling probes in the exhaust downstream from the filters during the ethylene oxide exposure study. In a subsequent amine exposure study, the multipoint sampling system was not used since the instrument was not calibrated for the test substances. During this study, portable IR instruments were used to monitor the chambers.

D. Environmental Measurements

1. Autopsy Room

The results of a one-half day environmental survey in the Autopsy Room (Room B-2) conducted on June 11, 1981, are reported in Table 1.

There are two downdraft autopsy tables which are on the same exhaust system with the two lateral exhaust benches in the adjacent Tissue Preparation room. These exhaust benches each have readily accessible dampers for operator adjustment of the airflow. Variations in these setting would have an effect on the flow at the autopsy tables. It would be very difficult to quantitatively evaluate the capture effectiveness of the downdraft tables. The use of smoke tubes showed that only the air immediately above the downdraft table surface would be captured. Contaminants washed down below the perforated top would be controlled in the absence of excessive cross drafts. The capture effectiveness would vary with the amount and distribution of surface area blockage by dissecting boards, formaldehyde containers, wetted paper towels under specimens, etc. It could easily vary widely for different work locations around the table. The ultimate test of effective controls and work practices is the level of exposure to the workers.

The survey was scheduled to observe rat sacrifices at the maximum level of activity, thereby identifying formaldehyde exposure during "worst case" conditions. It should be noted that autopsies of primates, because of their larger size, could present a different exposure which should also be evaluated at some future opportunity.

The Autopsy Room was staffed by five workers during the full activity period. However, a sixth worker was present and monitored only for the first hour while collecting blood specimens subsequently taken to the lab for analysis. All wore laboratory gowns, surgical gloves, and masks. In lieu of the surgical mask, one worker elected to wear an organic cartridge respirator. Results of the 4-hour time-weighted average (TWA) personal breathing zone samples for the Autopsy Room activity (See Table 1) for formaldehyde were all less than one fourth of the criteria formerly recommended by NIOSH based on irritant properties of 1.2 mg/m^3 for a 30-minute sampling period. Time-weighted average exposures ranged from 0.08 mg/m^3 to 0.18 mg/m^3 for the Autopsy Room workers. The Drager peak exposure tests did not reveal any levels above the lower detection limits of 0.6 mg/m^3. It was noted that the two highest TWA exposures were for the worker who changed the formaldehyde solution (recorder) and the worker who frequently inflated the lungs with formaldehyde (weigher). The hematology worker, who assisted the weigher, had a similar exposure for a shorter period of time.

The Measurements Research Branch of NIOSH has reported that there were some formaldehyde analyses during this period which were reported as much as 50% below the true value due to an analytical error. However, even with this possibility these exposures are not at a high level when compared to former criteria. However, it must be noted that based on recent findings both NIOSH and ACGIH have revised their criteria. The NIOSH Current Intelligence Bulletin No. 34 on Formaldehyde recommends that it be treated as a suspect carcinogen and that exposures be reduced to the lowest feasible limit.

2. Tissue Preparation Room

The Tissue Preparation Room (Room B-4) was evaluated June 11, 1981, the same day as the Autopsy Room during the same peak activity. The monitoring results are in Table 1. The two histology workers were monitored from 9:00 a.m. to 4:30 p.m. and 5:30 p.m., respectively. They prepare tissue specimens from organs preserved in solutions of formaldehyde. The procedure for tissue preparation involves use of formalin, alcohol, xylene, and paraffin. Personal breathing zone full shift samples for formaldehyde, xylene, and ethanol were taken

as well as the Drager tube tests for peak exposure levels. The TWA exposures to xylene and ethanol were far below the evaluation criteria (see Table 1). The xylene exposures were 0.57 and 0.21 mg/m^3 and the ethanol exposures were 1.95 and 2.08 mg/m^3 for the two workers. The formaldehyde results were higher than the Autopsy Room but still less than half of the former NIOSH irritant based criteria. The personal breathing zone formaldehyde levels were 0.43 and 0.57 mg/m^3 for Tissue Preparation Room workers. The Drager tube tests again showed no levels above the 0.6 mg/m^3 lower limit of detection. However, based on the NIOSH lowest feasible limit criteria for formaldehyde, improvements should be made.

The ventilation in this room is treated in detail in Appendix 2 of this report. One of the two Auto Technicon tissue preparation units was free standing in the middle of the room with a vacuum exhaust port that was discharged into the room. The other unit was located under the hood. The two partial horizontal hood sashes are unique to this laboratory. The workers were shown the effect of positioning of these sashes as demonstrated by smoke tube observations and velocity measurements. Effective control is dependent on keeping the sashes in front of the hood face, one on each half.

There were a large number of specimens awaiting processing stored in cartons containing formaldehyde on shelves and on the lateral exhaust tables. Plastic sheets were hung over the shelves to reduce the possibility of fumes. This is not an effective control measure. There were also boxes of plastic bags storing processed specimens for future reference. During the period of this survey NIOSH determined that these plastic storage bags sometimes leaked. Therefore the storage boxes were to be relocated to a tissue storage area elsewhere in the basement. There should be follow-ups on this new tissue archive to assure that it is ventilated and that proper archive management is instituted. Periodic checks for leaks and adequacy of ventilation control should be implemented.

3. Clinical Chemistry Laboratory

The Clinical Chemistry Lab (Room 301) was monitored on September 10, 1981. The results of the Clinical Chemistry Laboratory environmental measurements are shown in Table 2. The exposure levels for hexane, benzene, and acetone were measured during demonstrations of glass washing and MOCA column cleanup procedures. The large hood in Room 304 was used for these procedures. The exposure measurements did not exceed the recommended criteria as shown in Table 2. The highest of the triplicate personal breathing zone exposure levels for benzene were 2.7 for the MOCA procedure and 0.66

mg/m^3 for the glass washing procedure. Room area levels of benzene ranged from 0.09 to 0.12 mg/m^3. Since benzene is classified as a suspect human carcinogen, exposure should be controlled to the lowest feasible limit.

The large hood in Room 304 did not meet the EPA recommended minimum laboratory hood performance criteria for handling hazardous materials. When it was operated with the sash at a 17-inch height during the glass washing procedure, the average face velocity was 60 fpm. When it was operated with the sash at 20-inch height during the MOCA column cleanup procedure, the average face velocity was 45 fpm. The variation was much more than the recommended ±10 fpm from the average. Face velocities ranged from 20 to 100 fpm and 40 to 100 fpm for the two procedures. The smoke tube observations of airflow patterns were turbulent. During this measurement period, it was observed that Drager tube tests in the breathing zone were generally negative except that once there was a sudden partial color change. The reason for this erratic behavior was investigated further during the September ventilation survey. A similar sudden partial color change was observed when materials were discharged to the sink, as previously done in the MOCA cleanup, when a pedestrian would walk by the hood on the way through the door. Therefore, the exposure to benzene was above the lowest feasible control level. Workers were advised that the hood should not be operated with the sash above 12 inches when hazardous materials are used in order to maintain the recommended minimum of 100 fpm face velocity and a uniform flow pattern across the entire face. Even at this level the hood would not be expected to overcome interferences from crosscurrents caused by pedestrian traffic and the opening and closing of the nearby laboratory door. Therefore, to minimize exposures, the operator should control traffic and assure that the hood is lowered to 6 inches or less when not in use or when pedestrian traffic is present.

E. Observations

1. Respirator Protection Program

The respirator protection program was not well defined and lacked a written directive. There were cartridge respirators, masks, and self-contained breathing apparatus provided for use in various laboratories, however, workers' comments on their respirator training and on the maintenance of the equipment indicated a need for improvement. The Safety Office indicated that a formalized program was being implemented. Fit testing was underway for all animal handlers, chemists, and researchers. There was no written program documenting selection procedures or training activities. No mechanism for

periodic respirator maintenance was planned. There is a need for further development of this program i.a.w. OSHA regulations CFR 29 Part 1910.134 and the NIOSH Guide to Industrial Respiratory Protection.[23]

2. MOCA Study Procedure

This research project was mentioned in the union request and observed closely. It involved the dosing of rats with preparations of MOCA by gavage or skin application. The highest dose administered to a rat is 10 mg. The dosing material is prepared by the primary investigator in a hood located in Room B-42. The MOCA also is stored in this hood. The quantity of MOCA stored there was far in excess of that necessary for weekly use. The storage area and containers did not have adequate hazard markings. The hood performance was evaluated and found to be satisfactory. However, it does lack an air bypass, which results in unacceptably high air velocities when the sash is lowered. The moist dosing material presented no dust exposure hazard in the gavage procedures observed. Those handling the material wore laboratory coats and impermeable gloves. The procedure was accomplished in a containment facility within the exposure laboratory. The animal excrement was collected for analysis. Analysis was performed in the Clinical Chemistry Laboratory. Those involved in the project submitted urine for MOCA testing to confirm that no detectable absorption had occurred. The latex gloves used were reportedly tested by a member of the laboratory to ensure their impermeability to the acetone/MOCA preparation for the period of use in the dosing and laboratory procedure.

3. Chronic Exposure Laboratory

The chronic exposure laboratory (Room SB-04) air monitoring system and procedures for handling the animals were discussed with the supervisor, maintenance personnel, and the employees. The multiple fixed point air monitor is used to ensure that the animal exposure is maintained at the desired level as well as to identify any room air contamination and to ensure the chambers have been cleared of contaminant before opening. The employees are concerned about the possibility of residual contaminants in the animals and about the calibration of the monitoring system. The system is zeroed by injecting inert gas into the line. It is given an internal calibration check. It does not appear that the system is routinely checked against a standard of the contaminant in use. The workers are authorized to use cartridge respirators which were available on the shelf in the control room. There was varying

opinion on the adequacy of the training in use and of the maintenance of this equipment.

The investigators reviewed a log of the results of charcoal tube samples collected during the ethylene oxide animal exposure study. Samples were collected using low flow pumps at 50 cc/minute. Samples were taken for brief 20-minute periods in the animal chambers for comparison with the fixed point sampling results. They were taken for 80-minute peak personal breathing zone exposure assessments on animal handlers and in the vicinity of chambers and animal cages during chamber unloading procedures. The NIOSH employee who conducted the monitoring has had previous field survey experience. Reportedly, Quasi-Ketchum® ethylene oxide charcoal tubes were used. The analysis were performed by the NIOSH contract laboratory in accordance with NIOSH analytical Method S286 modified.[24] The results showed good correlation with chamber measurements and all personal and area peak exposure samples were below detectable limits of 0.01 mg per sample, which, if present at all, would be less than 2.5 mg/m^3 for a 4-liter sample. This survey was performed in January 13-19, 1981, and the results were indicative of a well-controlled work environment. The present PEL for ethylene oxide is 50 ppm (100 mg/m^3), however, this was established prior to the recognition of a cancer risk. The ACGIH TLV has been lowered to 5 ppm (10 mg/m^3) with an A2 classification (i.e., suspect of carcinogenic potential for man). NIOSH has not yet established a recommended exposure limit, however, they have recommended that this substance be regarded as a potential carcinogen.[25]

A similar monitoring effort was accomplished for a subsequent inhalation study, however, the results were not yet received at the last contact with this department in May 1982. This type of personal breathing zone monitoring should be performed at the beginning of each new exposure chamber project and if it is a prolonged study it should be repeated at regular intervals.

4. Men's Locker Room

The men's locker room (Room SB 58) is located at the opposite end of the hall from the majority of the laboratories and animal quarters. This is not an ideal arrangement, since the hallway may become contaminated with substances from the animal exposure chambers and the animal care areas. Fortunately, the sub-basement hallway is not a heavily trafficed area. Only one locker compartment is provided for each employee. This necessitates placing street clothing and work clothing in the same locker, which is not good practice,

since street clothing may become contaminated with toxic substances encountered at work.

5. Flammable Storage Dock B-2

The flammable storage room on B-2 dock has an exhaust fan which was turned off at the time of our visit. This fan should be running at all times, but since there is no access control to the fan switch, the fan can be switched off by any passerby. The storage cabinets are also individually vented. There are a number of users of this area with no apparent overall inventory or user controlling authority. This is a weak link in controlled use of hazardous materials at Taft Laboratories. Without user access controls, it is difficult to know where and under what conditions of use, the hazardous materials are consumed.

6. Cage Wash Rack

This facility (Room B-16) houses the cage wash rack, an acid bath, and utility sinks. The incinerator is also in this room. There were several improvements made in this area during the period of this survey. An eye wash was installed, skid resistant coatings were placed on the ramp to the wash rack, and guards were extended from the wash rack platform to the handrails to eliminate the possibility of stepping into the hot water below. There was concern expressed that manually pushing large monkey cages, which weigh several hundred pounds, up that ramp could result in injury should the worker slip. It is possible that this task could be mechanized by use of a lift or a winch system. This should be given further study and improvements made as feasible.

7. Cutaneous Hazards Laboratory

This facility (Room B-19) was not in use at the time of the survey. However, the ventilation survey revealed four areas of concern in this lab. The new exhaust system is operating far in excess of the flow recommended for effective controls. Also, one hood has the baffle removed, which further detracts from the intended control function. The flammable storage cabinet was not under negative pressure with regard to the room. There were two animal cage racks with venturi-type exhaust devices discharging into the hoods. The discharge hoses were hung from interior hood hardware by string. The passage of these hoses through the face of the hood along with the erratic and unreliable fastening method is not good procedure. The hoses should be provided with connection directly into the exhaust plenum exterior to the hood. The questionnaire response indicated that there were additional

cage exhaust units of this type planned for future use. While this would appear to be a good method of controlling cage emissions, numerous hoses discharging through the hood sash would not be acceptable. An additional note, a perchloric acid bottle was stored in one of these hoods and use of perchloric acid in these hoods could present an explosive hazard.

8. Isotope Metabolism Laboratory

This facility (Room B-23) was recently refurbished to accommodate radioisotope handling. The room is locked and access is controlled. The hood is located next to the door, but therefore could be a problem if traffic were allowed to pass during use. The additional canopy hood intended for control of animal cage rack emissions was evaluated and found to be ineffective unless a cage enclosure is provided.

There are three hand-held radioisotope survey meters. The two stored in Room B-25 were without batteries. The third is kept in the Safety Office. They did not have current calibration certification. Records are kept on swipe tests of sealed sources which are performed every 6 months. Swipe tests of laboratory work surfaces were reportedly accomplished. However, no records were maintained. Personnel routinely handling radioisotopes are in a thermoluminescent dosimeter monitoring program.

9. Pathology Laboratory

This facility (Room B-40) was noted to handle a number of chemicals on a daily basis and to have many other chemicals stored in the refrigerator in this room. The chemicals stored in this refrigerator were reportedly used by other laboratories and to give off odors from time to time. There appears to be a need for housekeeping in this refrigerator. A careful scrutiny for compatability, shelf life, and the condition of containers and labels is in order.

The need for a bench top enclosure to improve the slot capture effectiveness over the slide staining dipping trays is discussed in Appendix 2 along with hood improvements and interim operating recommendations.

10. Immunotoxicology Lab

This facility (Room B-41) is accessed through the cardiopulmonary Lab Room B-39. The unusually erratic nature of the hood face velocities and the reported variability of room pressure with respect to the adjoining lab warrant

further investigation. The workers viewed the materials commonly handled in this hood to be highly toxic based on the results of their current research findings. This situation was brought to the attention of the Safety Office at the time of the ventilation survey. For more detailed ventilation evaluation, see Appendix 2.

11. Hematology Laboratory

This facility (Room B-42) is used for a number of activities. The hood was observed to be used for MOCA mixing and storage, and drying of tissue slides during this survey. (See the MOCA project findings and Appendix 2 ventilation assesment.)

In addition, there is a Low Temperature Ashing Unit in this lab which uses an RF heat source. Reportedly, a prior survey recommended that the unit have additional RF shielding installed, which had not yet been accomplished. The unit was not marked to warn of RF emissions. Workers could conceivably sit in chairs next to this unit. The shielding was reportedly installed and RF measurements taken following our visit. Measurements were below the OSHA standard of 200 V/m (volts per meter) electric field strength and 0.5 A/m (amps per meter) magnetic field strength. It should be noted that there is a revised ANSI standard C95.1982 due for release in May 1982. This facility should be checked against the revised criteria when it is announced.

12. Electron Microscopy Laboratory

This facility (Room B-44) supports the Scanning Electron Microscope and the Transmission Electron Microscope. The ventilation assessment is in Appendix 2. Reportedly, there was a survey last year with negative findings for stray radiation from the X-ray source. This survey should be repeated whenever the unit undergoes maintenance or on a scheduled basis. Thermoluminescent Dosimeters are routinely used for personal and area source monitoring. In addition the question was raised regarding the possibility of hazards to hearing from this work environment. The NIOSH Acoustical Laboratory and audiometry specialists were consulted. There is no known potential for such a relationship with this work environment.

13. Former Surface Properties Laboratory

This facility (Room B-48) was converted to a darkroom and storage area. This room should be considered a confined space where chemicals are stored and used. The NIOSH recommendation for control of hydroquinone in photographic laboratories is

that a minimum of 4 air changes per hour be provided and that good housekeeping be maintained to avoid buildup of chemical contaminants on floors and work surfaces.[26] In addition to the photographic chemicals, there are chemicals from tissue preparation lab stored in the refrigerator. This type of joint storage area should be kept under close surveillance to ensure compatability of materials and responsible supervision.

14. Clinical Chemistry Laboratory

This facility (Room 301) has a hood which is reportedly used for other activities as needed. The hood is in a poor location and has cross draft interferences from the overhead return air supply. Perchloric acid was stored in this hood which doesn't have plumbing connections and is not approved for perchloric acid. Reportedly the room is frequently under positive pressure with respect to the hall although it was not at the time our observations were made. For a full discussion of the hood performance, see Appendix 2.

Three refrigerators, that store biological specimens and volatile chemicals used in the clinical chemistry laboratory, are located in the hall outside Room 301 at the entrance to the north elevators. One refrigerator is identified as explosionproof. It is used to store ether, carbon disulfide, and other volatiles. There is an odor from these solvents readily detectable in the elevator area when the fire doors are kept closed. There is no apparent ventilation in this area, and to avoid buildup of fumes, the fire doors must be kept open. It is not be advisable to locate this solvent storage unit in a laboratory occupied by workers and potential ignition sources, however, neither is it acceptable to use an unventilated elevator entrance way as a flammable storage area. This problem was discussed with the Safety Department and with the laboratory supervisors without reaching a satisfactory resolution. Clearly another more satisfactory solvent storage area should be provided in the vicinity of this laboratory.

15. Chromatography Laboratory

This facility (Room 302) is also known as the instrumentation laboratory. It contains atomic absorption, gas chromatograph, and liquid chromatograph instruments. The hood has four local exhaust takeoffs for the instrument siphons and for the nitrogen bubble drying hood in the adjoining laboratory (Room 304). The adjoining door is open and on the day of the ventilation survey Room 302 was negative with regard to Room 304. The hall door was held open with an elastic band which is normal practice to improve room ventilation. This hood has

been used for benzene and MOCA handling. The plumbing in this hood is not connected. A glove box has been procured and installed in Room B-23 for use in the MOCA procedures.

16. Trace Analysis Laboratory

This facility (Room 304) was used for the clinical chemistry procedures monitored for benzene exposure. (See environmental measurements reported in Section VI D of this report.) As discussed previously, under the conditions observed, the ventilation was found to be inadequate to meet the lowest feasible exposure criteria for highly toxic chemicals such as benzene. Reportedly, modifications have been made to provide improved interim measures until full correction can be made.

Reportedly there was a nitric acid wash spill during the period of this survey in this laboratory. The spill cleanup kits that had been placed in several laboratories were put to good use. It was noted however that there were insufficient backup supplies to replenish the acid spill kit. Materials were borrowed from other laboratory kits.

This laboratory is used by several chemists to perform laboratory tests and two chemists use this room as their office. Considering the inadequate hood, which can allow chemical substances such as benzene to escape into the room and the ever present danger to room occupants should explosions or chemical spills occur, it would be advisable to assign more appropriate office space to these two chemists.

17. Optical Radiation Laboratory

The "LASER" laboratory (Room 309) was visited; however no operational LASER observations were made. This lab also utilizes other potentially hazardous high energy optical sources such as a short arc xenon lamp (1 kw). The back drop for the laser target is a mobile black diffuse plywood surface. The only control of exposure to the path of the laser was operator procedure. The area was utilized by two part-time researchers in addition to the primary investigator. The laser is a Class 4 krypton/argon continuous wave tunable system manufactured by Coherent Radiation, Model CR-MG and severe ocular damage could occur should the laser beam enter an unprotected eye. It has a total 12 wavelength output of two watts ranging from 455 nm to 670 nm with a beam diameter of 1.3 mm and a 0.6 milli radians beam divergence. There were laser goggles available for various operating wavelengths. The room has warning signs posted however there is no warning light indicating when a hazardous energy source

is in use. An intercom has been installed to summon aid should a lone investigator need help.

The Optical Radiation Laboratory appeared to be less than optimum for use of a LASER system. The LASER beam and other high intensity sources should not be subject to possible reflection from objects in the room. There is an apparent need for a dedicated radiation range. The range should have proper surface treatments, warning devices, and interlocks and other engineering controls as specified below. There is also a need for improved storage facilities so that the range will not be cluttered by the array of instrumentation and equipment observed in this facility.

The American National Standard for the safe use of Lasers (ANSI Z136.1-1980)[17] defines Class 4 as an ultraviolet, infrared, or near infrared system which emits an average accessible radiant power in excess of 0.5 W for a period greater than 0.25 seconds.

Systems which are Class 4 should give priority to use of engineering controls. These controls should be used wherever feasible to reduce the classification for some applications. System enclosure is the best protection.

- A safety interlock shall be provided for any portion of the protective housing which can be removed without the use of tools.
- A key-switch master interlock or switching device shall be provided - the key shall be removable and the device shall not be capable of operation when the key is removed.
- When optical systems are used, in association with lasers, interlocks and or filters must be used to eliminate the increased eye hazard.
- A remote interlock connector should be provided on the hall door.
- A beam stop or attenuator should be permanently attached.
- An alarm or a warning light visible through protective eyewear should be used on laser activation or startup. There should be an emission delay to allow appropriate action prior to radiation.
- A laser controlled area should be established. This area must be under the direct supervision of an individual knowledgable in laser technology and laser safety.

- The area must be posted by warning signs and spectators access must have prior approval.

- The beam should be terminated in a beam stop and only diffuse reflective material permitted in or near the beam path. Requirements for beam stops of various wavelengths are specified in Paragraph 4.4 of the ANSI standard.

A Class 4 laser controlled area shall incorporate the safety measures as outlined in the ANSI standard Paragraph 4.2.12.2 which are discussed briefly as follows:

1) A safety latch or interlock to prevent unexpected entry into laser controlled areas. There must be provision for admittance and egress under emergency conditions.

2) All optical paths, such as windows in an interior facility, shall be covered or restricted in such a manner as to reduce the transmission values below the appropriate ocular maximum permissible exposure.

When engineering controls are not adequate to eliminate potential exposure in excess of the maximum permissible exposure (MPE), eye protection devices specifically designed for protection against the intensity and wavelength of radiation in use must be worn. The choice of optical density must be weighted to provide eye protection at the laser wavelength while meeting the need for adequate visible light transmission so that the operator can see adequately. In general, room lighting should be designed with the need for visible transmission through opaque goggles in mind. Supplemental lighting in areas where viewing tasks are performed will reduce the operators inclination to remove the eye protection for better task viewing.

18. Solar Radiation Laboratory

The "SUN" laboratory (Room 315) contains an exposure chamber with a 6500 watt source which permits exposure of test animals to a intense radiation spectrum that closely simulates sun light. The room is used intermittently to expose caged animals for brief periods. The exposure procedure was described. It involves opening the lower door of the exposure chamber and sliding out the cage while being careful not to stoop over and look up into the upper chamber where the sun source is operating. Even a brief glimpse of the source would cause eye damage. The rationale for not turning off the source is that the intermittent use would greatly shorten the life expectancy of the light sources. The room is posted and a warning light is activated outside the door when the

exposure procedures are taking place. It is the intention of the experimenter to build a second exposure chamber in an adjoining room and to have a much larger number of exposures conducted by other laboratory personnel. It would be advisable to revise the design of this exposure chamber to offer better protection to the eyes of the investigators.

The primary investigator has identified the need for additional ventilation to prevent ozone buildup from the light source operation. He has measured ozone levels above 10 ppm in the room air after brief periods of operation. Following installation of a local exhaust fan, levels did not exceed 0.1 ppm. This ventilation requirement should be carefully evaluated when installing the second unit in the small adjoining room for use on a routine schedule.

19. RF Microwave Laboratory

The Microwave Laboratory (Room 330) contains an RF exposure chamber. The chamber is shielded in a Faraday cage. The entrance has an interlock which will shut off the RF source should anyone open the door. Animal cages are placed into the exposure chamber which is not large enough for human occupancy. A warning light is activated when the system is turned on. This facility appeared to be well designed to avoid any accidental exposures.

20. Neurophysiology Laboratory

This facility (Room 402) contains three animal exposure chambers, an exposure generation hood, and a 12 channel fixed location monitoring system. The animals are housed and fed in the chambers. Cartridge respirators are provided and a SCBA is located nearby. Workers varied in their judgment on the adequacy of training in its use.

The generating hood and monitoring system also support a human exposure chamber in the adjoining Room 404. The cage exhaust system is filtered through charcoal before discharge to the outside. For a full discussion of the hood and local exhaust system see Appendix 2.

21. Mass Spectrometry Laboratory

This facility (Room 453) is dedicated to gas chromatography and mass spectrometry instrumentation. There was employee concern about noise levels which reportedly interferred with communications. Measurements were taken on September 11, 1981. The levels measured at the desk were 65 dBA with the air-conditioner running and 62-63 dBA without it. Next to the

air-conditioning unit 77 dBA. These levels are well below the threshold for risk of noise induced hearing loss. The most conservative criteria which is recommended by NIOSH is a 85 dBA 8-hour TWA.

A sound band analysis of this noise would permit the evaluation of the Speech Interference Level (SIL) which is the basis for evaluation of communication interference criteria. This was not accomplished during our survey due to the large time commitment that would be required to perform this analysis and other higher priority evaluations. However, based solely on the dBA overall sound pressure levels observed, the 1965 and 1966 ASHRAE Guide and Data Book recommends design goals of 40-50 dBA for ventilation noise in Hospital Laboratories and 40-55 dBA for general open offices and drafting rooms. These are general guides which do not mean that any level within the range will be satisfactory. In addition to the sound level, it is necessary that the quality of the sound is such that it will not be annoying, even though the level is not substantially above background.

F. Waste Disposal

The handling of waste material is the last step in the custody of hazardous materials. It requires a good deal of attention not only because of the complexity of the combined waste hazard's potential but also due to the various regulations which now control hazardous materials waste disposal. The Centers for Disease Control completed a contractor survey of the overall agency's waste handling.[27] This report deals with Taft Laboratories in detail and should be consulted for their recommendations. Their findings focused on the need for labeling of wastes, a new incinerator with increased capabilities, and provisions for pretreatment of the high hazards chamber wastewater. The present incinerator is characterized as obsolete and inadequate.

The question was raised by workers concerned that emission from the incinerator might be contaminating the work area and the nearby cafeteria. The incinerator was undergoing refurbishment during the initial walk-through. It was observed in use during the September follow-up. The small combustion chamber requires that animal carcases be repositioned in the center of the flame after partial incineration. This procedure results in an unpleasant odor in the immediate vicinity when the incinerator door is opened. Other than this, it was not observed to cause odiferous emissions. The kitchen pantry area which the incinerator flue pipe passes through was also observed. No defects or odors were present. Kitchen staff had no recollection of any odors emitting from the pantry area.

G. Animal Colony

The standard operating procedure for the care and handling of the laboratory animals generally conforms to the recommendations of the Guide for the Care and Use of Laboratory Animals[19] and the CDC Lab Safety Manual. The attendants wear laboratory coats and paper masks when in the animal quarters. Gloves are worn when they handle the animals.

Air pressure in the animal care rooms should be negative with respect to the hallways to prevent the escape of biological and chemical substances from the animal care rooms. However, the ventilation in the animal colony was found to be unbalanced with some rooms under positive pressure with respect to the halls and others under negative pressure.

Because of the nature of their work, animal care workers are at increased risk of accidents and may be at increased risk of developing certain infections. The health of animal care workers is discussed in the medical results section.

H. FDA Biophysiology Branch

The branch chief and the FDA Safety Officer for the FDA Cincinnati Food Laboratories were most cooperative in conducting a walk-through of their areas in the Taft facility and orienting the investigators on their work. They referred to the CDC Proposed Biosafety Guidelines for Microbiological and Biomedical Laboratories.[28] They also provided copies of their Branch's Biosafety Guidelines which were distributed under a cover memo of February 18, 1981.

This group's activities are associated with field lab support, research, and animal studies. These activities varied depending on the needs at particular times. However, there were some common threads. The lab does not do studies of unknown contaminants. They deal with cultures of food borne agents to determine field investigation methods and to recommend control measures. They claimed not to handle agents with a known significant potential for airborne transmission at the Taft Facility. The branch chief classified the agents he worked with as Level 2 Biohazards as defined in Reference No. 28. He particularly noted that whenever a "large" quantity of material was used it was handled in biohoods which have High Efficiency Particulate (HEPA) filters and discharges to the room air.

Biohood systems are designed as much to keep the bacterial culture being worked with from being contaminated as to prevent worker exposures. The FDA hoods are under a maintenance contract. The filters are serviced annually. A pressure gauge is mounted on each

hood to keep a check on its performance. The gauge indicates the pressure change across the filters. Should it drop to a very low level it would mean a hole had developed in the filter system. If it becomes very high it would mean that the air flow was blocked and service was needed. The lab has only one chemical hood which is used solely for the storage of chemicals. More detailed criteria for biohood classification and use are provided in Reference Nos. 29, 30, and 31. Also, FDA was provided a copy of a Draft EPA Users Manual for Laboratory Containment Devices.

All FDA animal experiments are conducted at a FDA owned animal test facilities in a nearby building. They are separate except for the use of the preparation room which is located on the third floor of Taft Labs. Cultures and small amounts of animal tissue are used in the lab during the course of an experiment.

From our walk-through observations and discussions with the Branch chief and lab personnel, the following comments are made.

1. There is a need to improve the storage of long term and ready to use supplies. The concern is to maintain clear floors and counters for easy cleaning and disinfection. They pointed this out and stated that efforts were underway to reduce ready storage to a minimum.

2. There should be a close link between the FDA labs safety program and the NIOSH program to assure proper control measures are provided, proper housekeeping arrangements are made, and proper responses in case of emergencies such as spills or fires.

I. Occupational Medical Program

The primary goal of any health program is to maintain the "wellness" of its participants. In addition, an Occupational Health Program has three special goals: the prevention of occupational disease, the early detection of any occupational disease that may develop, and the prompt and proper evaluation and treatment of any employee who has an occupational accident or illness. To accomplish the first goal, the physican conducting the medical health surveillance must be familiar with the employees potential exposures to hazardous substances and work in conjunction with the members of the health and saftey committee (research scientists, industrial hygienists, saftey officer, etc.) to minimize the employee's potential exposure to hazardous substances or physical agents. In addition with certain exposures, he may see that the employees have the proper immunizations to protect from diseases to which thay may have increased exposure (eg. tetanus in animal care workers or botulism in bacteriologists working with botulism organisms).

In a research facility, since the workers can be exposed to a great variety of toxic substances and some adverse effects may not become evident for years after the exposure, the second goal, the early detection of diseases of occupational origin can be difficult to accomplish. Adverse health effects that have a long latent interval before expression, usually cannot be detected early in their course by periodic health assesement, but periodic medical examinations can successfully detect the more quickly expressed effects of toxic chemical exposure such as elevation in liver enzymes after excessive exposure to certain solvents. For employees exposed to agents such as benzene, which can depress the bone marrow where most blood cells are formed, it may be advisable to perform quarterly blood counts. With exposures to certain physical agents, it may be advisable to monitor the condition of certain sensitive organs such as the ear (with hearing tests) in employees exposed to high noise levels, or to obtain a baseline eye examination by an opthalmologist in employees who work with lasers. For some exposures, it may be appropriate to monitor blood or urine to detect levels of the toxic substance or its metabolic products to assure that excessive exposure is not occuring.

Because of the wide range of normal values of most clinical lab tests, it is very difficult to differentiate early disease from biologic variability when reviewing lab tests on an individual who may have some laboratory test values that are at the upper range of normal or slightly elevated. In these cases, the pattern of this employee's previous tests, repeat testing, and the examination of the clinical laboratory tests of other employees who have similar work exposures can be of aid in determining if there may be occupational factors adversely affecting the employee and his similarly exposed coworkers.

The goal of providing prompt and proper treatment for occupational injuries or illness can be difficult at a research facility, since many of the potential exposures are uncommon and may produce unusual signs and symptoms and require special modes of therapy with which the physicians in the community may not be familiar. Thus for employees who become exposed to excessive levels of toxic chemicals, it is important to be prepared to provide complete information regarding the toxicity and modes of therapy for the agent of exposure and to follow-up on progress of therapy. For example, if an employee receives a monkey bite wound to the hand, it is important that the treating physician be familiar with the high likelihood of infection in such wounds.

The Health Services Administration of the Public Health Service operates a clinic at Taft. The clinic is staffed by a registered nurse, and emergency care for illness or injuries is available from 7:30 to 4:00, Monday to Friday. Employees who incur occupational injuries are seen by the nurse and if the nurse decides that

treatment by a physician is required, the employee is refered to his personal physican.

An annual physical exam is offered to all DBBS employees at Taft who have potential occupational exposure to hazardous agents. Prior to the exam, the employee completes a form describing the potentially hazardous chemical substances and physical agents to which he has been exposed. The physical exam is performed by one of several physicians under contract to the PHS. This physician reviews the results of the physical exam as well as the clinical laboratory data. (A complete blood count, chemistry panel, audiometry, and EKG are done on all employees. At the descretion of the examining physician, a tuberculin skin test or chest X-ray may be performed on selected individuals.) The employee is informed of any abnormalites in lab tests or physical findings. If the examining physician feels any abnormal findings may be the result of occupational exposure, the records for that examinee are sent to a designated NIOSH physician and this NIOSH physician follows up on these results at his discretion.

In the last two years several potentially serious accidents have occurred at the Taft facilities. Several employees were exposed to possibly excessive levels of methyl bromide. After these exposures occurred, the potential health consequences of the exposures were unclear and several days were required to decide on the proper course of medical evaluation for the exposed workers. In early 1981, two individuals who work in the animal care wing suffered monkey bite wounds to the hand. Like human bite wounds to the hand, monkey bite wounds are likely to become infected. Both wounds were cleaned and dressed at the Taft clinic, but when these employees were seen by their personal physicans one to two days following their injuries, serious infection was present in their wounds. Both injured employees required several months of treatment and one employee required partial amputation of a finger.

Animal care personnel have been reported to be at increased risk of developing allergic reactions to animal dander and animal excreta. None of the eight animal care workers interviewed reported presently experiencing work associated allergic symptoms, but there were several scientists who used rats in their research who did have respiratory allergies to rats. Animal care personnel also may acquire systemic infections from the laboratory animals. Primates, especially, may harbor infectious agents such as tuberculosis or certain viruses that can be pathogenic to humans. Because of this risk of infection, serum samples from each animal husbandry employee were obtained in the Spring of 1981, so that should an illness occur and an elevated antibody titer to certain viral or bacterial agents be found, it could be determined if the high antibody titer was a recent development. While all current employees had a serum sample sent to CDC for storage, there is no

mechanism at present to assure that new employees will have such a reference sample drawn or that samples will be obtained from current employees on a periodic basis.

In order to evaluate the recordkeeping proceedures employed in the medical monitoring program, 50 medical charts, chosen at random, were briefly reviewed. No findings that suggested adverse health effects from occupational exposures were noted beyond several occupational injuries and the above-noted respiratory allergies, methyl bromide inhalations, and monkey bite wounds.

To lessen the danger of primate-borne tuberculosis, the Taft primates receive a TBC skin test every three months. The CDC Lab Safety manual recommends that, as a further precaution for the animal care personnel, workers handling primates receive TBC skin tests every six months, but the clinic medical records did not contain recent (within one year) results of TBC skin tests or chest X-rays on the majority of the animal care personel. CDC also recommends that animal care workers be kept currently immunized against tetanus but the current tetanus immunization status of many of the animal care employees could not be determined from the clinic records and several of these employees could not recall when their last tetanus booster was received.

At the present time, the PHS Health Services Administration Medical Clinic at Taft provides adequate occupational health care for the Taft NIOSH employees working in the Divisions other than DBBS, since these employees do not work directly with hazardous substances or physical agents. However, the occupational health program for the DBBS employees could be improved if an occupational physician, familiar with the work practices and occupational exposures of the DBBS employees, was designated to act as a consultant to the DBBS Safety Committee.

With some types of occupational exposure, it is possible that the general annual exam may not be of sufficient frequency and/or may not contain clinical tests that are especially appropriate for employees conducting research projects entailing exposure to certain agents. Thus, it is important that, during the planning phase of new projects, the DBBS Safety Committe, working in conjunction with the medical consultant, determine if specialized medical surveillance is appropriate for the employees to be engaged in the new project. A similar review for existing projects should be conducted regarding medical surveillance and the potential need for special medical evaluation or treatment should acute chemical exposures or physical injuries occur. Special attention should be given to the occupational groups with exposures entailing unusual hazards (eg. animal care workers, benzene exposed workers, laser research workers, etc.) and recommendations should be made with respect to the evaluation and treatment of employees who experience

acute toxic chemical inhalations or suffer occupational injuries with a special danger of infection such as hand wounds from monkey bites.

VII. RECOMMENDATIONS

A. Administrative

1. Establish a workable Hazardous Materials Management Program covering procurement, custody, handling, emergencies, and waste disposal procedures.

2. Establish a routine surveillance system for ongoing review of project safety plans and periodic inspection of custody inventories, personal exposures, and ventilation controls.

3. Establish a formal respirator protection program to ensure that all of the requirements of OSHA 1910.134 are fully met for selection, training, fit testing, maintenance, and storage.

4. Implement the recommendation of the CDC contractor's waste disposal study. Priority should be given to replacement of the incinerator.

5. The need for additional on-the-shelf backup materials for the spill kits should be reviewed. There should be sufficient material on hand to meet any forseeable need without depleeting the supply. Personnel should be trained in use of the kits and familiarized with kit instructions.

6. The radiation monitoring instruments should be serviced and kept in current calibration.

7. Whenever the services of NIOSH employees are called upon to perform in-house environmental evaluations for occupational health purposes, their findings should be formally documented in a report. There were a number of instances where it was reported that evaluations had been made, but no written reports were readily available to document the positive or negative findings. These included the finding of a hydrazine and nitrosamine survey in the boiler room, Room B-19, Room B-05, and the fourth floor of Taft Labs, the RF survey of the Low Temperature Asher in B-42, the X-ray survey of the Transmission Electron Microscope in Room B-44, the ozone measurements in the Sun Lab 315, and the swipe samples taken to check for work area contamination in Room B23 and 25.

B. Ventilation

1. Establish a Fume Hood Surveillance system similar to that used in the EPA program including the engineering specifications, and design criteria for each system. Post the maximum permissible interim operating height using an official label similar to the EPA certification.

2. Contract an engineering study of the overall ventilation system to update the ventilation blueprints and determine a course of action to provide a balanced and functional laboratory ventilation system.

3. Correct the numerous fume hood deficiencies as detailed and discussed in the Appendix 2, some of which are highlighted throughout this report.

4. Install gauges to monitor the performance of each hood on a daily basis.

5. The Tissue Preparation Room (B-2) Auto Technicon tissue preparation unit exhaust port should be correctly vented and the atmosphere tested periodically for adequacy of vapor controls.

6. Provide enclosure for the animal cage exhaust canopy in Isotope Metabolism Lab Room B-23.

7. Provide appropriate animal cage venturi exhaust discharge connections to the exhaust plenum in the Cutaneous Hazards Lab Room B-19. Also adjust hood flow rates and repair and adjust baffles to obtain even flow patterns. Then check the flammable storage cabinet for negative air pressure.

C. Rooms B-2 and B-4

1. Provide a means of lessening formaldehyde fumes during the emptying of containers in sinks. A funnel directly to the drain could reduce the splash and wetted surface areas. The workers should continue to use care in pouring and provide ample water to flush the residual from the sink. Similar work practices should be encouraged in the autopsy activity.

2. Ensure that user of the Tissue Preperation Hood and Autopsy Downdraft Tables are instructed on the proper damper adjustment to achieve the optimum control from the system where needed.

3. In addition to the recommendations above it is necessary to continue a periodic monitoring of the exposures and controls

in these Autopsy and Tissue Preparation facilities to assure that the lowest feasible criteria is being meet. It would be prudent to make measurements under the various exposure conditions, such as primate sacrifices, which might alter the exposure levels.

D. Room 309 and Room 315

The Optical Radiation Laboratory appeared to be less than optimum for use of a LASER system. There is an apparent need for improved storage and a dedicated radiation range with proper surface treatments, warning devices, interlocks, and other engineering controls as outlined in Section VI.E.15 of this report and detailed in ANSI standard for the safe use of lasers (Z136.1 - 1980).

The Sun Lab animal exposure chamber should be modified to assure positive control of workers eye exposures during cage handling procedures.

E. Occupational Health Program

An occupational physician should be designated to act as consultant to the DBBS Safety Committee. The committee, in conjunction with this medical consultant should review present policies and procedures concerning the DBBS occupational health program and establish clear written policies regarding the medical surveillance and immunization requirements for DBBS employees. Special attention should be given to the occupational groups with exposures entailing unusual hazards (eg. animal care workers, benzene exposed workers, laser research workers, etc.) and recommendations should be made with respect to the evaluation and treatment of employees who experience acute toxic chemical inhalations or suffer occupational injuries with a special danger of infection such as hand wounds from monkey bites.

VIII. REFERENCES

1. Chamberlin, R.I. and Leahy J.E. Laboratory Fume Hood Standards, Recommended for the U.S. Environmental Protection Agency (Contract No. 687-01-4661). M.I.T. Cambridge, Massachusetts: 1978.

2. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 6, 2nd ed. Cincinnati, OH: National Institute for Occupational Safety and Health, 1980. (DHHS (NIOSH) publication no. 80-125).

3. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 1, 2nd ed. Cincinnati, OH: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-157-A).

4. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to benzene. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1974. (DHEW publication no. (NIOSH) 74-137).

5. Statement of Edward J. Baier, Deputy Director, NIOSH, CDC, HEW before the DOL, OSHA Public Hearing on Occupational Standards for Benzene, July 25-26, 1977.

6. Patty FA. Patty's industrial hygiene and toxicology. Vol II--toxicology, 3rd revised ed. New York: John Wiley & Sons, 1978.

7. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to xylene. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1975. (DHEW publication no. (NIOSH) 75-168).

8. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1981. Cincinnati, Ohio: ACGIH, 1981.

9. National Institute for Occupational Safety and Health (NIOSH)/Occupational Safety and Health Administration (OSHA). Occupational Health Guidelines for Chemical Hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health (NIOSH)/Occupational Safety and Health Administration (OSHA), 1981. (DHHS (NIOSH) Publication No. 81-123).

10. National Institute for Occupational Safety and Health/Occupational Safety and Health Administration, Current Intelligence Bulletin 34 Formaldehyde: Evidence of Carcinogenicity. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1980 (DHHS (NIOSH) Publication No. 81-111).

11. National Research Council Committee on Hazardous Substances in the Laboratory. Prudent Practices for Handling Hazardous Chemicals in Laboratories. Washington, D.C.: 1981, National Academy Press.

12. American Conference of Governmental Industrial Hygienists. ACGIH industrial ventilation: a manual of recommended practice. ACGIH Committee on Industrial Ventilation: Lansing, Michigan, 1982.

13. NIOSH Technical Information. Recommended Industrial Ventilation Guidelines. Cincinnati, Ohio, 1976 (DHEW (NIOSH) Publication No. 76-162).

14. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to noise.

Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1973. (DHEW publication no. (NIOSH) 73-11001).

15. Petersen APG and Gross Jr. EE: Handbook of Noise Measurement: General Radio, 1972.

16. Guide and Data Book Systems and Equipment, 1967 of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. (ASHRAE) 1967.

17. American National Standard Institute, Inc. American National Standard for the safe use of lasers. New York, New York: American National Standards Institute, Inc., 1980 (ANSI Z136.1-1980).

18. Center for Disease Control. Lab safety at the Center for Disease Control. Atlanta, Georgia: Center for Disease Control. (DHEW Publication no. (CDC) 79-8118).

19. Institute of Laboratory Animal Resources of the National Research Council. Guide for the care and use of laboratory animals. National Institute of Health, 1978. (DHEW Publication no. (NIH) 78-23).

20. National Institute for Occupational Safety and Health. A Management System for Occupational Safety and Health Programs for Academic Research Laboratories. National Institute for Occupational Safety and Health, 1979 (DHEW (NIOSH) Publication No. 79-121).

21. Health and Human Services (HHS). Guidelines for the Laboratory Use of Chemical Substances Posing a Potential Occupational Carcinogenic Risk, Revised Draft March 1980.

22. Environmental Protection Agency (EPA) Occupational Health and Safety Chapter 8 Laboratory Use of Toxic Substances Draft, 1982.

23. National Institute for Occupational Safety and Health. NIOSH technical report - A guide to industrial respiratory protection. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1976. (DHEW Publication no. (NIOSH) 76-189).

24. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 3, 2nd ed. Cincinnati, OH: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-157-C).

25. National Institute for Occupational Safety and Health/Occupational Safety and Health Administration. Current intelligence bulletin 35 ethylene oxide (EtO). Cincinnati, Ohio: National Institute

for Occupational Safety and Health, 1981. (DHHS (NIOSH) Publication no. 81-130).

26. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to hydroquinone. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1978. (DHEW publication no. (NIOSH) 78-155).

27. Roy F. Weston Inc. contract survey of CDC Waste Disposal dated April 1981

28. Center for Disease Control (CDC) Proposed Biosafety Guidelines for Microbiological and Biomedical Laboratories, Atlanta, Georgia.

29. National Cancer Institute (NCI) Effective Use of the Laminar Flow Biological Safety Cabinet.

30. The National Sanitation Foundation (NSF) Standard No. 49 for Class II (Laminar Flow) Biohazard Cabinetry. The National Sanitation Foundation: Ann Arbor, Michigan, 1976.

31. Environmental Protection Agency (EPA) Laboratory Containment Devices User's Manual Draft 1982.

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7. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

RESULTS OF AIR SAMPLES FOR FORMALDEHYDE, XYLENE, AND ETHANOL
ROBERT A. TAFT LABORATORY AUTOPSY (B-2) AND TUSSUE PREPARATION ROOMS (B-4)
CINCINNATI, OHIO
HETA 81-180

JUNE 11, 1981

ROOM ID	JOB CLASSIFICATION	SAMPLE PERIOD START	STOP	VOL. (l)	FORMALDEHYDE mg/m^3	XYLENE mg/m^3	ETHANOL mg/m^3	SAMPLE NOTES
AUT	DISECTING	8:39a.m.	12:40p.m.	110.9	0.11			
AUT	DISECTING	8:41a.m.	12:20p.m.	98.6	0.09			
AUT	RECORDER	8:42a.m.	12:36p.m.	100.6	0.13			(a)
AUT	WEIGHING	8:43a.m.	12:22p.m.	92.0	0.18			
AUT	SECTIONING	9:05a.m.	12:25p.m.	88.0	0.08			(b)
AUT	HEMATOLOGY TECH	8:44a.m.	10:00a.m.	32.7	0.18			
TPR	HISTOLOGY TECH.	8:59a.m.	4:20p.m.	88.2	n/s	0.57	1.9	
TPR	HISTOLOGY TECH.	8:60a.m.	4:20p.m.	79.2	0.43			
TPR	BIOLOGY TECH.	9:10a.m.	5:30p.m.	95.0	n/s	0.21	2.1	(d)
TPR	BIOLOGY TECH.	9:10a.m.	5:30p.m.	95.0	0.57			

LIMITS OF DETECTION: (units per sample)		0.006 mg/spl	0.01 mg/spl	0.01 mg/spl
EVALUATION CRITERIA:				
NIOSH	-TWA	LFL	435.0	N/A
	-Ceiling	N/A	870.0	N/A
	(sample period)	N/A	10(min)	N/A
ACGIH	-TLV	C 3.0(e	S 435.0	1900.
	-STEL-TLV	N/A	S 655.0	N/A
OSHA-PEL	-TWA	3.6	435.0	1900.
	-Ceiling	6.0	N/A	N/A
	-Peak	12.0	N/A	N/A
	(peak period authorized)	30(min)	N/A	N/A

NOTES: SEE TABLE 1 NOTES CONTINUED ON NEXT PAGE.

AUT - Autopsy Room (B-2).
TPR - Tissue Preparation Room (B-4).
n/s - not sapmled for
N/A - No criteria exists or it is not applicable

NOTES: TABLE 1 CONTINUED HE 81-180

a) This pump had a low flow light indication. Possibly due to the tendency of workers to ocasionaly lean back against the wall behind them. Not expected to be a significant period of flow restriction.

b) This worker's sample hose was disconnected from the pump for what is believed to be less than 10 minutes.

d) More than 30% of the ethanol was in the backup section of the tube.

e) 1981 intended change to A2 classification.

C Designates a ceiling value not to be exceeded at any time.

S Skin annotation - substance toxic through skin.

A2 Industrial substance suspect of carcinogenic potential for man.

ACGIH American Conference of Governmental Industrial Hygienists.

TLV® Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes.

STEL Short Term Exposure Limit - the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposures.

TWA For ACGIH AND OSHA- The time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.
For NIOSH- The time-weighted average concentration for a normal work period up to 10 hours per day and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

CEILING For ACGIH - The concentration that should not be exceeded even instantaneously.
For OSHA - The permissible ceiling for an 8-hour day.
For NIOSH- The concentration that should not be exceeded at any time and that should be measured over a specified short-term sampling period.

PEAK OSHA acceptable maximum peak above the ceiling for a specified maximum duration.

LFL For NIOSH- Lowest Feasible Limit - since it has not been shown that safe levels of carcinogens exist, but risk is reduced if exposure is reduced.

TABLE 2

RESULTS OF AIR SAMPLES FOR HEXANE, BENZENE, & ACETONE
NIOSH TAFT LABORATORIES ROOM 304
CLINICAL CHEMISTRY LABORATORY
CINCINNATI, OHIO
HETA 81-180

SEPTEMBER 10, 1981

LOCATION / JOB CLASSIFICATION	SAMPLE PERIOD START	STOP	VOL (l)	HEXANE mg/m^3	BENZENE mg/m^3	ACETONE mg/m^3
(The morning measurements are during a simulated MOCA column cleanup procedure.)						
AREA center desk	9:21a.m.	10:50a.m.	9.79	<1.0	<0.102	
AREA center desk	9:21a.m.	10:50a.m.	10.76	<0.93	0.092	
AREA corner desk	9:22a.m.	10:50a.m.	10.03	<1.00	0.099	
AREA corner desk	9:22a.m.	10:50a.m.	10.56	<0.95	0.094	
AREA (hood sash)	9:24a.m.	10:50a.m.	9.46	<1.1	0.528	
AREA (hood sash)	9:24a.m.	10:50a.m.	8.60	<1.2	0.465	
PBZ Lab Worker	9:20a.m.	10:50a.m.	3.87	5.2	2.58	
PBZ Lab Worker	9:20a.m.	10:50a.m.	3.78	2.6	2.64	
PBZ Lab Worker	9:20a.m.	10:50a.m.	9.90	4.0	2.72	
(The afternoon data is for the simulated glass cleaning procedure.)						
AREA center desk	1:05p.m.	2:20p.m.	8.25	<1.2	0.121	<3.6
AREA center desk	1:05p.m.	2:20p.m.	8.25	<1.2	<0.121	<3.6
AREA corner desk	1:08p.m.	2:20p.m.	7.70	<1.3	<0.129	<3.9
AREA corner desk	1:08p.m.	2:20p.m.	8.49	<1.2	0.117	<3.5
AREA (hood sash)	1:08p.m.	2:20p.m.	8.78	<1.1	0.341	3.4
AREA (hood sash)	1:08p.m.	2:20p.m.	3.02	<3.3	0.331	9.9
PBZ Lab Worker	1:05p.m.	2:20p.m.	2.25	<4.4	0.444	13.0
PBZ Lab Worker	1:05p.m.	2:20p.m.	3.00	<3.3	0.666	10.0
PBZ Lab Worker	1:05p.m.	2:20p.m.	7.50	<1.3	0.666	4.0
ANALYTICAL LIMITS OF DETECTION: (units per sample)				0.01 mg/spl	0.001 mg/spl	0.03 mg/spl
EVALUATION CRITERIA:						
NIOSH	-Ceiling			1800.	3.2(LFL)	N/A
	(sample period)			15(min)	60(min)	N/A
ACGIH	-STEL-TLV					2375.

NOTES:

<	LESS THAN-These samples were below the detection limit and therefore airborne levels if present at all were less than the level shown.
ACGIH STEL	American Conference of Governmental Industrial Hygienists. Short Term Exposure Limit - the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposures. The TWA TLV must not be exceeded. This criteria is not to be used as a design criteria.
CEILING	For NIOSH- The concentration that should not be exceeded at any time and that should be measured over a specified short-term sampling period.
PEAK	OSHA acceptable maximum peak above the ceiling for a specified maximum duration.
LFL	For NIOSH- Lowest Feasible Limit - since it has not been shown that safe levels of carcinogens exist, but risk is reduced if exposure is reduced.

APPENDIX 1

EXPOSURE CRITERIA AND HEALTH EFFECTS

HETA 81-180

ROBERT A TAFT LABORATORIES
CINCINNATI, OHIO
FEBRUARY 1982

This appendix is a brief overview of the principles and practices used by Industrial Hygienists and other qualified Occupational Health Professionals in applying exposure criteria. For a full understanding of any criteria, it is necessary to refer to the documentation used in making the criteria recommendation.

There are thousands of chemical and physical hazards in the workplace for which there are little or no information upon which to base a health effects exposure limit. There are a few hundred that have been sufficiently documented to be published by one or more professional groups or government agencies. Two of the most widely recognized are the American Conference of Governmental Industrial Hygienists list of Threshold Limit Values (TLVs^R) and the National Institute for Occupational Safety and Health (NIOSH) Recommended Standards for Occupational Exposure. The Occupational Safety and Health Administration has promulgated a number of Permissible Exposure Limits (PELs) which, for the most part, were adopted from the 1968 TLV professional guides and are now standards. When available, all three of the above have been provided in these tables. The particular guide of choice depends on its intended use and limitations.

There are several general statements that can be made regarding the origin, limitations, and application of most of the exposure limit criteria:

Exposure criteria for chemical contaminants are given in units of airborne concentrations which is primarily related to toxic inhalation hazards. However, they may also be annotated as toxic by entry through the skin. This annotation warns of the need for precautions to avoid skin absorption which would invalidate the airborne exposure limit. Similarly in general there is a need to ensure that toxic exposures through ingestion are controlled by good personal hygiene, food handling, and contamination control.

These criteria are based on the best available information from industrial experience, from experimental human and animal studies, and when possible from a combination of all three. The basis on which the values are established may differ from substance to substance; protection against immediate impairment of health may be a guiding factor for some, whereas reasonable freedom from irritation, narcosis, nuisance or other forms of stress which could result in health effects may form the basis for others.

The amount and nature of the information available varies from substance to substance. Consequently, the precision of the estimated criteria is

also subject to variation and the latest documentation should be consulted in order to assess the extent of the data available for a given substance.

The criteria represent exposure conditions under which it is believed that nearly all workers may be repeatedly exposed for five eight hour days a week for a working lifetime without adverse effect. Because of a wide variation in individual susceptibility, a small percentage of workers may experience discomfort from some substances at concentrations at or below the exposure limit; a smaller percentage may be effected more seriously by aggravation of a pre-existing condition or by development of an occupational illness. In spite of the fact that serious injury is not believed likely as a result of exposures to the exposure limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.

These criteria are for single-substance exposures and specified work schedules. Exposures to a combination of chemicals under a variety of physical conditions and work schedules requires adjustment of these criteria based on sound knowledge and profesional judgment. This adjustment is more difficult when some of the exposures are to chemicals of unknown or poorly documented toxicity. These uncertainties add to the need to minimize exposure to atmospheric contaminants.

Threshold Limit Values for mixtures are addressed by the ACGIH as follows; "When two or more hazardous substances are present, their combined effect rather than that of either individually, would be given primary consideration. In the absence of information to the contrary, the effects of the different hazards should be considered as additive..." It is also possible to have other effects from combined exposures such as synergistic action or potentiation. A synergistic effect is a combined toxicity greater than that expected from the two single toxicities added together. A potentiation effect is one which increases the toxic effect of a toxic hazard; potentiative and synergistic agents are not necessarily harmful by themselves. Potentiation effects are often caused by exposures other than inhalation, e.g. imbibed alcohol and inhaled narcotic (trichloroethylene).

Carcinogens, teratogens, and mutagens must be treated cautiously since unlike other toxicants the effect is a potentially serious disease irrespective of the exposure which caused it. However, the exposure level does appear to have a direct relationship on the likelihood of having these effects. Therefore to minimize the risk, it is prudent to minimize the exposure.

There are three catagories of airborne exposure limits: the Time Weighted Average (TWA), the Short-Term Exposure Limit (STEL), and the Ceiling Limit (C).

The TWA is a calculated average exposure level for a specified period, typically eight to ten hours per day and fourty hours per week. TWA's permit exposures above the limit provided they are compensated by equivalent excursions below the limit during the work period. There is a limit to the excursions that are permissible above the listed values. This limit is based on guidelines which take into account such factors as acute toxicity at higher concentrations, whether the effects are

cumulative, the frequency of occurrence of peaks and their duration. All factors must be considered in making a judgment as to whether a hazardous condition exists.

The STEL is the maximal concentration to which a worker can be exposed for a period up to 15 minutes without suffering from 1) irritation, 2) chronic or irreversible tissue change, 3) narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions per day are permitted, with at least sixty minutes between exposure periods, and provided that the TWA-TLV is also not exceeded. The STEL should not be used as a design criteria.

The Ceiling Limit (C) is the concentration that should not be exceeded even instantaneously. The STEL is also to be considered a ceiling limit.

OSHA's Accepted Maximal Peak above the eight hour TWA specifies the applicable maximum duration for each substance so treated.

NIOSH Ceiling limits specify the short-term sampling period required for commonly available monitoring methods to detect the ceiling limit. This does not represent acceptance of a TWA excursion above the ceiling/peak exposure limit.

When referring to the following tables of criteria and effects, it is necessary to keep the principles and practices discussed above in mind. To interpret or apply these numbers to any particular set of environmental conditions, the advice and council of a qualified occupational health professional is necessary.

TABLE I OF APPENDIX 1

ENVIRONMENTAL CRITERIA AND PRINCIPAL HEALTH EFFECTS FOR AIRBORNE CONTAMINANTS
[Please note:this table is not to be duplicated without Appendix 1 text.]

JANUARY 1982

UNITS ARE GIVEN IN BOTH: PARTS PER MILLION PARTS OF AIR BY VOLUME (ppm) / AND THE EQUIVALENT / MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3)

COMPOUNDS AND (SYNONYMS)	ACGIH (TLV) TWA [ppm] mg/m^3	ACGIH (TLV) STEL [ppm] mg/m^3	OSHA (PEL) TWA [ppm] mg/m^3	OSHA (PEL) CEILING [ppm] mg/m^3	OSHA (PEL) PEAK [ppm] mg/m^3	NIOSH TWA [ppm] mg/m^3	NIOSH CEILING [ppm] mg/m^3	PRINCIPAL HEALTH EFFECTS TARGET ORGANS AND [REFERENCES]	NOTES
Benzene C_6H_{12}	A2[10.0]	A2[25.0]	[10.0]	[25.0]	[** 50.0]	---- ----	[1.0]	LEUKEMIA [NIOSH CRITERIA] effects blood, bones,	**10'
(SYN: Coal Tar Naphtha)	A2 30.0	A2 75.0	30.0	75.0	150.0	---- ----	*3.2	CNS, eyes, respiratory system.	*60'
Ethyl Alcohol	[1000.0]	---- ----	[1000.0]	---- ----	---- ----	---- ----	---- ----	Mild eye and nose irritation, headache drowsy,	
(SYN:Ethanol,Grain Alcoho)	1900	---- ----	1900	---- ----	---- ----	---- ----	---- ----	tremors,& fatigue. (SYNERGISTIC)	
Formaldehyde	# A2	---- ---	[3.0]	[5.0]	[** 10.0]	LFL	---- ---	SUSPECT CARCINOGEN-[CURENT INTELEGENCE BULLETIN	**30'
(SYN: Formalin)	# A2	---- ----	3.6	6.0	** 12.0	LFL	---- ---	No.34] Eye, skin, and respiratory irritant;	
n-Hexane	#[50.0]	---- ----	[500.0]	---- ----	---- ----	[100.0]	*[510.0]	POLYNEUROPATHY-[NIOSH CRITERIA ALKANES] Lt.head	*15'
(SYN:Hexyl hydride)	# 180.0	---- ----	1,800.0	---- ----	---- ----	360.0	* 1,800	,giddy,nausea,headache, irr; eyes,nose, skin.	
Hexane (Other than normal)	#[500.0]	#[1000.0]	---- ----	---- ----	---- ----	---- ----	---- ----	Effects skin, eyes and nose causing Lighthead	
(SYN:Hexyl hydride)	# 1800.0	#3600.0	---- ----	---- ----	---- ----	---- ----	---- ----	,giddy,nausea,headache, irr; eyes,nose, skin.	
Xylene(o-,m-,p-isomers)	[*100.0]	[*150.0]	[100.0]	---- ----	---- ----	[100]	[**200]	Central Nervous System, GI tract, blood, liver,	*SKIN
(SYN: Xylol)	435.0	655.0	435.0	---- ----	---- ----	435.0	**870.0	kidneys,& skin. Dizzy, Stagger, nausea, vomit	**10'

NOTES:

(*, **)	notes in right column for each entry.
#	indicates that the following value is a proposed revision to the TLVs.
C	Designates a ceiling value not to be exceeded at any time.
A2	Industrial substance suspect of carcinogenic potential for man.
ACGIH	American Conference of Governmental Industrial Hygienists.
TLV®	Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes.
STEL	Short Term Exposure Limit) - the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposures.
TWA	For ACGIH AND OSHA- The time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. For NIOSH- The time-weighted average concentration for a normal work period up to 10-hours per day and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.
CEILING	For ACGIH - The concentration that should not be exceeded even instantaneously. For OSHA - The permissible ceiling for an 8-hour day. For NIOSH- The concentration that should not be exceeded at any time and that should be measured over a specified short-term sampling period.
PEAK	OSHA acceptable maximum peak above the ceiling for a specified maximum duration.

APPENDIX 2
HETA 81-180

LOCAL EXHAUST PERFORMANCE EVALUATION
ROBERT A. TAFT LABORATORIES
SEPTEMBER 1981

The assessment of local exhaust performance in this appendix is based on the Laboratory Fume Hood Standards, Recommended for the U.S. Environmental Protection Agency. They were reported in January 1978 by R.I. Chamberlin and J.E. Leahy under EPA Contract No. 68-01-4661. The application of this laboratory fume hood standard is outlined briefly in the executive summary included here from that report.

EXECUTIVE SUMMARY

The laboratory fume hood if designed, installed, operated, and maintained properly will provide personnel with a high degree of protection and allow the user to work with a wide range of potentially hazardous materials.

The design of the basic laboratory hood and its capability to provide desired control can be evaluated by existing performance testing procedures. Assurance that the equipment can meet such criteria is essential.

Hood performance is a function of airflow characteristics as well as quantity. Not enough emphasis has been placed on these characteristics and too much emphasis has traditionally been placed on quantity. External factors have a great effect on hood performance. Of these, hood location and room air turbulence from any number of sources are of prime concern. Where such conditions exist, they should be corrected as the first step in any program to up-grade laboratory hood performance.

The manner in which make-up air is provided is very important. This air should reach the hood face in a manner that enhances overall hood performance. It should "fill-in" the low pressure area in front of the operator without causing other adverse turbulent conditions.

The control velocities required at the hood face range from 80 FPM for ideal laboratory situations to 100 FPM for good arrangements. These flow rates will provide the worker protection desired for any operations that should be performed in this type of equipment. Flows lower than those proposed do not provide the safety factors desired for normal conditions such as operator movement. Higher flows than those proposed are not required for "good" laboratory arrangements and do not improve performance for "poor" arrangements.

"Ideal" (1) Excellent location, end of room or bay, no door or window problems.
(2) Essentially no pedestrian traffic, other than hood operator.
(3) All of the required laboratory hood make-up air, drawn or induced, so as to enhance overall hood performance. For example, a properly designed and located perforated ceiling section or well-designed auxiliary air-type hood plenum.
(4) No other grilles or diffusers exist that produce air at measurable velocities in the hood area.

"Good" (1) Good location, no door or window problems, and not on a main aisle.
(2) Minimum traffic other than hood operator.
(3) Have air supplied to lab so velocity from diffusers or grilles does not exceed 25 FPM in vicinity of hood.

"Poor" Where any one or more of the conditions noted above are not met.

Tests indicate that hood system designs which incorporate true control of the air in the area in front of the hood operator are safer than conventional exhaust hoods.

This appendix provides a one page summary of each laboratory hood evaluation based on criteria similar to the EPA criteria. It also includes comments on other local exhaust systems and the general air balance of the rooms with respect to the hallway. Each assessment is patterned after the EPA method with modifications.

The face velocity measurements are shown for fully open sash and for the sash lowered to six inches from the working surface, for each vertical sash hood. The basis of assessing adequacy of performance is included for each case. The average face velocity and total flow volumes are calculated. In the case of Ideal or Good environmental factors and fully open sash the average face velocity should be between 80 and 100 FPM and the measured velocities should not vary more than 10 FPM from the average. The velocities measured with the sash at a height of 6 inches should be at least twice but not more than 3 times the measurements taken with the sash fully open.

The room rating is based on the quality of the room environment. It is judged primarily upon the amount of cross draft found with the hood closed. The EPA method called for measurements of ambient air currents in the hood face with the hood off. Most of the Taft Lab hoods are not shut off, therefore measurements of ambient air curents were taken with the hood sash closed in a plane lateral to the face and approximately 3 inches out from it. There is of course a direct relationship between the location of the hood in the room and the cross-draft effect from room air registers and doors. Therefore two hoods in the same room can have different room ratings.

The suitability of the hood location is judged on the basis of pedestrian traffic patterns around the hood. This evaluation is independent of the room rating discussed above.

The Titanium Tetrachloride flow pattern observations were taken by slowly drawing the smoke tube across the face about four inches inside the hood and at various levels to observe the currents and eddies. This provides a more complete representation of the hood's flow patterns and capture effectiveness.

The EPA protocol also calls for a one-minute smoke bomb discharge to measure the effectiveness of smoke removal with the sash fully raised, at six inches, and closed. This test was considered to be too time consuming to be applied to the 28 hoods evaluated in this Hazard Evaluation.

The EPA requires considerable documentation on each system such as; fan size, number of belts, static pressures, filters, work surfaces, controls, lighting, slots, bypass, etc. This information should be readily available to the facilities engineer to assist in performance checks, however, it is beyond the scope of this survey to provide such extensive documentation. An example of the Hood Card File is provided as Figure 1 of this appendix.

The absence of bypasses on most of the Taft Lab hoods should be recognized as a general deficiency which will not be commented on for each location. The excessively high face velocities measured at the 6-inch sash height are indicative of the problem. It is not practical to close these hoods. Therefore, effectiveness of control during periods of nonuse is dependent on the position the sash is left in and the interference in the room environment.

Materials used in the hoods should also be documented along with their toxicity and control requirements. This is a topic which will require considerable inhouse effort to devise mechanisms to provide continuing surveillance. This survey identified only a fraction of the uses of each hood and is not intended to assess the overall adequacy of use for each procedure.

The ventilation performance evaluation provided here is a starting point to assess various applications now in use or anticipated for use in various hoods. In cases where general performance deficiencies were identified, they are commented on with some suggested approach to improve the performance.

In addition to the Laboratory Hoods there are a number of local exhaust hoods which are used for various special applications. These were also discussed on the same page with the hood in the comment section for each room location. The data is present in order of the room numbers. If more than one hood is in a room it is identified by location in the room.

Maximum sash height recommendations are made for most of the hoods. These values are based on face velocity and smoke tube observations at the time of the survey, at the recommended height. The use of these work practice limitations is not considered a correction for the deficient ratings in Hood Location and Room Factors. This level will provide a minimum interim control only if the adverse environmental factors are also controlled. The ultimate corrective measures should include provisions for all of the deficiencies. A few examples of acceptable and unacceptable corrective measures follow.

1. Where the room factor is poor due to air discharge in excess of 25 fpm across the hood face, a register deflector may provide an inexpensive means of correction.

2. Where cross currents are created by pedestrian traffic or door movements, it may be more cost effective to build a wall isolating the hood from traffic than to move the hood.

3. Where one of two doors in a laboratory is the cause of a poor rating, it is acceptable practice to place, emergency egress only, hardware on that door. This effectively eliminates the poor traffic pattern rating in many cases. Signs alone would not be adequate control of traffic.

4. Where the hood face velocities and smoke tube observations can be adjusted to provide acceptable interim control, the hood should be posted with an official NIOSH approval similar to the adhesive backed sticker used by EPA as shown in Figure No. 2.

Summary Findings for
Taft Laboratories Fume Hood Performance Evaluation
by EPA Fume Hood Criteria

September 1981

Room #	Hood Location	Room Pressure	Face Velocity Analysis: Average Full Open FPM	Average Full Open CFM	Variation (<±10 FPM)	At 6" FPM	At 6" CFM	Less Than 3X Avg. Velocity	Room Factor Rating	Hood Location Rating	Smoke Tube Observation
B-04	Tissue Preparation	-	92	1434	Yes	(Horizontal Sash)		Yes	G	G	S†
B-04**	Left Exhaust Table	-	202	912	No	(No Sash)		Yes	G	G	S
B-04**	Right Exhaust Table	-	340	1536	No	(No Sash)		Yes	G	G	S
B-19	SW Corner	NP	240	2790	No	508	1313	Yes	UK	G	S
B-19	SE Corner	NP	370	2674	No	556	892	Yes	UK	G	U
B-23	Next to the Door	NP	(46)	435	Yes	122	254	Yes	G	G††	U
B-40	Histology	NP	89	1214	No	430	1164	No	G	G	U
B-41	Immuno Tox Lab	NP	(56)	410	No	225	365	No	P	P	U
B-42	Hematology	NP	149	1274	No	715	1310	No	G	I	S
B-44	Tech Svc Br	-	(56)	414	No	216	343	No	P	P	U
B-60	Hood on Left	PP	80	637	No	280	478	No	P	G	S
B-60	Hood in Middle	PP	78	628	No	318	543	No	P	G	U
B-60	Hood on Right	PP	79	632	No	310	529	No	P	G	S
B-66	Training Eqt Rm	PP	(62)	496	No	266	455	No	P	P	U
301	SW Corner	NP	(50)	409	No	273	449	No	P	P	U
302	SE Corner	-	110	851	No	463	752	No	P	P	S
304	SE Corner	PP	(34)	626	No	182	655	No	P	P	U
304	Far Corner	PP	(20)	67	No	76	71	No	I	I	S
402	Outside Wall	NP	86	728	No	335	663	No	P	G	S
424	Between Door & Air	-	(60)	912	Yes	Broken Sash Cables					
430	Far Corner	NP	191	1379	No	463	743	Yes	I	I	S
449	South Wall	NP	(48)	762	No	275	813	No	P	P	U

(continued)

Summary Findings ... (continued)

Room #	Hood Location	Room Pressure	Face Velocity Analysis: Average Full Open FPM	Average Full Open CFM	Variation (<±10 FPM)	At 6" FPM	At 6" CFM	Less Than 3X Avg. Velocity	Room Factor Rating	Hood Location Rating	Smoke Tube Observation
449	West Wall, SW Corner	NP	123	1134	No	(Half open)					
-	With Dbl. Ver. Sash	NP	87	1522	No	232	610	Yes	P	P	U
452	South Wall	-	128	1008	Yes	410	802	Yes	P	P	S
460	Perchloric Acid	NP	184	3213	No	760	2739	No	I	I	S
460	Center of Room	NP	(37)	355	Yes	160	283	No	G	G	S
461***	Wall by Door	NP	145	1978	No	103	266	Yes	G	P	S

NP = Room under negative pressure w.r.t. hall.
PP = Room under positive pressure w.r.t. hall.
S = Satisfactory
U = Unsatisfactory
P = Poor
G = Good
I = Ideal
UK = Unknown - cannot evaluate until excessive rates of exhaust are adjusted
† = This is true only when both sashes are placed in front of the opening and not both on one side.
†† = Requires strict observance of work practices. Door locked and lower sash if necessary to open.
** = Not a hood - Lateral exhaust tables no sashes.
*** = Not a standard hood configuration (Housing and Instrument).

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-04 Location: Tissue Preparation Lab. . NIOSH #10598

Type of Hood: Standard__ Auxillary Air__ Other: Lateral sliding sashs

Flow with sash full open.

Face Velocity Measurements		
90	100	100
90	90	90
90	90	90

Sub Total 830 Number of data points 9

Avg. Face Vel. (fpm) 92
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height (avg.) =h (in.) 35. Width =l (in.) 64.
Conversion sq feet 144. Area =a (sq. ft.) 15.5
Flow q= (CFM) 1,434

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

000	000	000	000

Sub Total --- N/A Number of data points

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 0
Height h= N/A Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 0.0
Flow q = (CFM) 0

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory__ Describe; This was true only when the two sliding sashs were placed in front of the hood opening and not both on the same side.

Room Rating: Good; Return air was provided along the full length of the walls opposite each of the hoods. It entered at ceiling height (8-10 feet).

Hood Location: Good; The only passing traffic is the technician using this hood.

Recommended Sash Height: See Comments

Materials used in hood: Formalin, Xylene, Ethanol, Formic Acid, others.

COMMENTS: These measurements reflect the two horizontal sliding doors positioned one on each half of the face. The actual operating conditions observed were with both doors on the right side and pushed beyond the limits of the face. This resulted in a much less desirable capture velocity pattern with losses due to turbulence in the lower left quadrant around the Tecnicon® instrument housed in this hood.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-04 Location: Two Lateral Exhaust Tables along the wall

Type of hood: Standard__ Auxillary Air__ Other: Two exhaust tables with sashes

Left Exhaust Table.

	Face Velocity Measurements		
(damper half open)	225	265	110
	185	210	220
Sub Total----	1,215	Number of data points	6

Avg. Face Vel.(fpm) 202
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height =h (in.) 11 Width =l (in.) 59
Conversion sq. ft. 144 Area =a (sq. ft.) 4.5
Flow =q (CFM) 912

Right Exhaust Table.

	Measured Velocities (fpm) and their (Sum)		
(damper full open)	335	430	360
	335	360	225
Sub Total --- 2,045	Number of data points	6	

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)
Avg. Vel. (fpm) 340
Height h= 11 Width = 59
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 4.5
Flow q = a x f (CFM) 1,536

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory__ Describe; Even with considerable air blockage from cluttered table tops, the capture appeared good. Only on one end of one table where blockage was complete was there a slight problem.

Room Rating: Good; Return air provided along the opposite wall at ceiling height.

Hood Location: Good; The only traffic is the technician working there.

Recommended Sash Height: N/A

Materials used in hood: Formalin, Xylene, Ethanol, and Zeukers fluid.

Comments: The excess Formalin from tissue containers is poured off in the sinks under the slot exhausts. A damper is readily adjustable for each table; the effect of partial closing of the damper was observed in the left hood measurements.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-19 Location: South West Corner Hood# UK

Type of hood:Standard__ Auxillary Air X Other:_____

Flow with sash full open.

Face Velocity Measurements		
250	310	335
220	255	240
200	240	110

Sub Total 2,160 Number of data points 9

Avg. Face Vel. (fpm) 240
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height =h(in) 27 Width =l (in) 62
Conversion sq. ft. 144 Area =a (sq. ft.) 11.6
Flow =q (CFM) 2,790

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)
500 525 500 000
Sub Total --- 1,525 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 508
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 2.5
Flow q = (CFM) 1,313

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory Describe; The face velocities were much too high for practical use. After adjustment to an appropriate working level the flow pattern should be reassessed.

Room Rating:Return air provided along two walls at ceiling height. (However, unable to assess ambient air current effects due to excessive hood exhaust rate.)

Hood Location:Good; No traffic other than hood user.

Recommended Sash Height:Unable to evaluate - see comments below.

Materials used in hood:Unknown

Comments: This facility is used for Cutaneous Hazards studies.
The local exhaust system for the two hoods in this room are operating at three times the recommended flow rate. This is wasteful in terms of energy and is not a practical working environment. Velocities above 250-300 fpm create problems in handling materials and heavy turbulence. This room was under negative pressure w.r.t. the hall. The ventilated storage cabinet was not under negative pressure w.r.t. the room. This should be corrected.

The discharge of venturi local exhaust systems for cage racks should be extended to a point in the hood exhaust plenum.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-19 Location: South East Corner Hood# UK

Type of hood:Standard__ Auxillary Air X Other:_____

Flow with sash full open.

Face Velocity Measurements		
430	575	800
310	310	250
185	250	225

Sub Total 3,335 Number of data points 9

AVG. Face Vel.(fpm) 370
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in) 27 Width =l (in) 38.5
Conversion sq. ft. 144 Area =a (sq. ft.) 7.2
Flow =q (CFM) 2,674

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

620	525	525

Sub Total --- 1,670 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 556
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.6
Flow q = (CFM) 892

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory__ Unsatisfactory X Describe; The air velocities were much too high for practical use. After they are adjusted to appropriate working levels the flow pattern should be reassessed. This hood was in poor repair. The baffel had been completely removed from the back, resulting in the extreme variations in face velocity and highly turbulent flow.

Room Rating:Return air provided along two walls at ceiling height, however, unable to assess ambient air current effects due to excessive hood exhaust rate.

Hood Location:Good; No traffic other than hood user.

Recommended Sash Height:Unable to evaluate - see comments below.

Materials used in hood:Unknown; Perchloric acid, Formaldehyde, and acetone were present.

Comments: This facility is used for Cutaneous Hazards studies.
The local exhaust system for the two hoods in this room are operating at three times the recommended flow rate. This is wasteful in terms of energy and is not a practical working environment. Velocities above 250-300 fpm create problems in handling materials and heavy turbulence. This room was under negative pressure w.r.t. the hall. The ventilated storage cabinet was not under negative pressure w.r.t. the room. This should be corrected. The baffel should be replaced to restore even airflow. The discharge of venturi local exhaust systems for cage racks should be extended to a point in the hood exhaust plenum.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-23 Location: Next to the door. Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
55	55	48
40	48	40
48	44	40

Sub Total 418 Number of data points 9

AVG. Face Vel.(fpm) 46

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in) 27 Width =l (in) 50
Conversion sq. ft. 144 Area =a (sq. ft.) 9.3
Flow =q (CFM) 435

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

138	138	90

Sub Total --- 366 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 122
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 2.0
Flow q = (CFM) 254

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory __ Unsatisfactory X Describe; With hood full open, the face velocity was too low. Capture at the work surface was very poor. The flow pattern was satisfactory at the recommended sash height.

Room Rating: Good; Return air did not produce cross drafts above 25 FPM.

Hood Location: Good; Satisfactory only with controlled access and work practice listed below:

Recommended Sash Height: 16" provides greater than 80 FPM; 12" provides greater than 100 FPM.

Materials used in hood: Radioisotopes (6 C14 labeled chemicals).

Comments: This room is a radioisotope laboratory. It was at a negative pressure w.r.t. the hall. The hood location makes it subject to drafts from door opening and pedestrian traffic. The door is normally locked to control access, the hood user should be able to lower the sash to 6" when opening and closing the door.

The canopy hood, recently installed in this room to control emissions from cages, would be ineffective without full enclosure of the cage rack. It exhausted approximately 400 CFM. Even at the face of the hood, 7 feet above the floor, the capture velocity was less than 40 FPM.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-40 Location: Histology Lab Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
110	110	155
70	62	110
35	35	120

Sub Total 807 Number of data points 9

Avg. Face Vel.(fpm) 89

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 30 Width =l (in.) 65
Conversion sq. ft. 144 Area =a (sq. ft.) 13.5
Flow =q (CFM) 1,214

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

430 430 430

Sub Total --- 1,290 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 430
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 2.7
Flow q = (CFM) 1,164

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory __ Unsatisfactory X Describe; The fully-open position allows heavy turbulence in the lower left quadrant of the opening. Baffels should be provided to even the flow. Also, a bypass to allow closing of the hood.

Room Rating: Good; Return air is provided from registers at ceiling height along the room centerline. Lateral cross drafts were less than 20 FPM.

Hood Location: Good; Traffic in and out of the storage room should be controlled during hood use.

Recommended Sash Height: 18" high for velocities greater than 140 FPM.

Materials used in hood: Xylene, Epoxy Plastic, Formaldehyde.

Comments: This hood is used to prepare electron microscope tissue samples. With the recommended face velocity the smoke capture pattern is acceptable. There is a lateral slot exhaust above a section of bench where tissue staining is accomplished by sequentially dipping trays in dishes of xylene and various staining agents. The Capture velocity over the row of trays closest to the slot is 40 to 80 FPM. The second row's Capture velocity is 15 to 40 FPM and the third row fluctuates. The dipping would likely disrupt all of these airflows. A partial enclosure would greatly increase the effectiveness of this local exhaust control. This room was under negative pressure w.r.t. the hall. There were a large number of chemicals stored in a refrigerator in this room. There appears to be a need for improved cold-storage facilities.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-41 Location: Immuno Toxicology Lab NIOSH 12259

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

	Face Velocity Measurements		
(average-highly varied)	62	44	55
	66	86	35
	44	55	58

Sub Total 505 Number of data points 9

Avg. Face Vel.(fpm) 56

(Under ideal to good physical conditions should be 80-100 fpm and measured values should not vary from the average more than (±) 10 fpm)

Height=h (in.) 27 Width =l (in.) 39
Conversion sq. ft. 144 Area =a (sq. ft.) 7.3
Flow =q (CFM) 410

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

225 225 225

Sub Total --- 675 Number of data points 3

(Readings should be at least 2 but not more than 3 times the value with the sash fully raised)

Avg. Vel. (fpm) 225
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.6
Flow q = (CFM) 365

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory __ Unsatisfactory X Describe; The pattern was generally good, however, the variability of the face velocity could not assure stability of this system.

Room Rating: Poor; The air supply flows across the face, also the flow through the doorway in front of the hood varies from positive to negative.

Hood Location: Poor; Traffic to and from this lab must pass through the door in front of the hood.

Recommended Sash Height: For greater than 150 fpm use 13 inch; For 100 fpm, 20 inches.

Materials used in hood: Allyamine, triethylamine, 2-2-2-Nitrile Triethanol, Triethylamine, others.

Comments: This is the immunotoxicology laboratory.
In view of the highly variable face velocity and the use of toxins which are being studied for highly toxic effects the 150 fpm sash height is considered prudent particularly in view of the location of the air supply and doorway above and in front of the hood respectively. One explanation offered for the variable face velocities is that this hood may be on the end of a very long mutiple exhaust system. This hood deserves further study. This room was under negative pressure w.r.t. room adjoining. However, reportability is not usually true.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-42 Location: Hematology Lab Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
150	155	185
138	125	150
138	125	175

Sub Total 1,341 Number of data points 9

Avg. Face Vel.(fpm) 149
(Under ideal to good physical conditions should be 80-100 fpm and measured values should not vary from the average more than (±) 10 fpm)

Height=h (in.) 28. Width =l (in.) 44.
Conversion sq. ft. 144. Area =a (sq. ft.) 8.5
Flow =q (CFM) 1,274

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

715	715	715

Sub Total --- 2,145 Number of data points 3

(Readings should be at least 2 but not more than 3 times the value with the sash fully raised)
Avg. Vel. (fpm) 715
Height h= 6 Width =l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.8
Flow q = (CFM) 1,310

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory __ Describe; Good capture, however, when sash is lowered, the velocity is much too high - materials lifted from work surface.

Room Rating: Good; There were no ambient cross drafts above 20 FPM.

Hood Location: Ideal; at the back of the room - no incidental traffic.

Recommended Sash Height: See comments.

Materials used in hood: MOCA, Xylene.

Comments: The use of this hood was not well defined. The storage of MOCA and cleaning of tissue slides with xylene were observed uses.

The hood is exhausting a very large amount of air. If the sash is lowered at all, it results in excessive air velocities which interfere with materials handling. If the flow were adjusted lower and a bypass were provided, this hood would perform well under good operating conditions. This room was under negative pressure w.r.t. the hall.

The RF low-temperature asher located in this room should be evaluated to determine adequacy of RF shielding. Reportedly a prior survey found it deficient.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-44 Location: Tech Service Br. Hood#SN 11210

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
70	70	70
55	55	35
62	44	44

Sub Total 505 Number of data points 9

Avg. Face Vel. (fpm) 56
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 28 Width =l (in.) 38
Conversion sq. ft. 144 Area =a (sq. ft.) 7.3
Flow =q (CFM) 414

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)
220 210 220
Sub Total --- 650 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 216
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.5
Flow q = (CFM) 343

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory __ Unsatisfactory X Describe; Flow was obstructed due to storage of 4 gallons of acetone on the left side of the hood.

Room Rating: Poor; Replacement air discharge in front of hood.

Hood Location: Poor; Walkway to and from scanning EM Laboratory.

Recommended Sash Height: 16" for velocity above 100 FPM.

Materials used in hood: Chloroform, Acetone, Fluorocarbons, "Bulk Dust Samples".

Comments: This lab is used to prepare samples for scanning EM analysis. The walkway can be controlled to reduce interference during hood use. A bypass would allow closure of the hood without causing unduly high air velocities and still guarding against ambient air currents from personnel movements.

The hood could not be shut off or fully closed, therefore, it was not possible to measure ambient replacement air effects at the face of the hood. The position of the return air duct would allow discharge to the hood face area, however, the register was not on at the time of this survey.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-60 Location: On left next to sliding door. Hood# Uk

Type of hood: Standard X Auxillary Air__ Other:_____

Flow with sash full open.

Face Velocity Measurements		
100	78	70
110	80	62
78	80	62

Sub Total 720 Number of data points 9

Avg. Face Vel.(fpm) 80
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 28 Width =l (in.) 41
Conversion sq. ft. 144 Area =a (sq. ft.) 7.9
Flow =q (CFM) 637

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)
280 280 280
Sub Total --- 840 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 280
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.7
Flow q = (CFM) 478

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory__ Describe; Visual evidence of cross draft effect was minimal.

Room Rating: Poor; ambient lateral airflow at face with all three hoods sashs closed exceeds 40 FPM on right side of face.

Hood Location: Good; At end of room with minimum of incidental traffic.

Recommended Sash Height: 22" for velocity above 100 FPM.

Materials used in hood: Unknown.

Comments: This is one of three hoods side by side at the end of a classroom. The overhead return air register had less effect on this hood's performance than the one in the middle. This room was under positive pressure w.r.t. the hall.

Note: There was no measurable face velocity at the time of this survey. There was also a vented flammable storage cabinet which had no perceptable draw as measured by velometer and smoke tubes at the air entrance port.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-60 Location: Middle of three side by side Hood# UK

Type of hood: Standard X Auxillary Air__ Other:_____

Flow with sash full open.

Face Velocity Measurements		
100	90	66
86	80	62
86	70	70

Sub Total 710 Number of data points 9

Avg. Face Vel.(fpm) 78
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 28 Width =l (in.) 41
Conversion sq. ft. 144 Area =a (sq. ft.) 7.9
Flow =q (CFM) 628

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)
310 310 335
Sub Total --- 955 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 318
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.7
Flow q = (CFM) 543

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory__ Unsatisfactory X Describe; The overhead air supply register created a strong downdraft across the right half of the hood face. Dragout occurred across most of the face of the hood.

Room Rating: Poor; Air supply register blowing down across face at velocities up to 100 FPM with a lot of fluctuations.

Hood Location: Good; at end of room with minimun of pedestrian traffic.

Recommended Sash Height: 22" for a velocity above 100 FPM. (See Comments).

Materials used in hood: Unknown.

Comments: This is one of three hoods side by side at the end of a classroom. This hood was seriously affected by return air drafts. The registers air stream should be redirected out of the side of the duct rather than down across the hood face. Otherwise, the 100 FPM face velocity would not be adequate.

This room was under positive pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B-60 Location: on Right in the Corner Hood# UK

Type of hood:Standard X Auxillary Air__ Other:_____

Flow with sash full open.

Face Velocity Measurements		
100	80	100
90	66	70
80	66	62

Sub Total 714 Number of data points 9

Avg. Face Vel.(fpm) 79
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 28 Width =l (in.) 41
Conversion sq. ft. 144 Area =a (sq. ft.) 7.9
Flow =q (CFM) 632

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

310	310	310

Sub Total --- 930 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 310
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.7
Flow q = (CFM) 529

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory__ Describe; Only slight turbulence noted in lower right corner. Visual evidence of cross draft effect was minimal.

Room Rating: Poor; Ambient lateral airflow at face with the sash closed exceeded 30 FPM on the left side and fluctuated greatly.

Hood Location: Good; At end of room with minimum pedestrian traffic.

Recommended Sash Height: 22" for face velocities above 100 FPM.

Materials used in hood: Unknown

Comments: This is one of three hoods side by side at the end of the classroom. The overhead return air register had less effect on this hood than the one in the middle. This room was under positive pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: B 66 Location: Training Equipment Area Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

	Face Velocity Measurements		
(hood fully open)	80	70	80
	70	70	58
	58	30	44

Sub Total 560 Number of data points 9

Avg. Face Vel. (fpm) 62

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (±) 10 fpm from the average.)

Height=h (in.) 28 Width =l (in.) 41
Conversion sq. ft. 144 Area =a (sq. ft.) 7.9
Flow =q (CFM) 496

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

275 275 250

Sub Total --- 800 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 266
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.7
Flow q = (CFM) 455

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory __ Unsatisfactory X Describe; This hood has an unusual amount of turbulence and losses from the leading edge of the work surface.

Room Rating: Poor; There is a strong cross draft at the lower edge of the face, likely from a return air register above the door.

Hood Location: Poor; In the path for pedestrian traffic from three doors.

Recommended Sash Height: 12" to provide face velocities above 150 FPM and reduce turbulence at the leading edge of the work surface.

Materials used in hood: Unknown

Comments: This room is primarily for training staff use. The hood sash counterbalance weights need adjustment and the slots should be adjusted to increase the proportion of air drawn from the bottom. The use of a air foil might be helpful in reducing leading edge turbulence. The air register discharge should be deflected away from the hood. This room was under positive pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 301 Location: SW Corner by door Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
44	90	80
24	44	44
24	62	44

Sub Total 456 Number of data points 9

Avg. Face Vel.(fpm) 50

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 29.5 Width =l (in.) 39.5
Conversion sq. ft. 144 Area =a (sq. ft.) 8.0
Flow =q (CFM) 409

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

290 290 240

Sub Total --- 820 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 273
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.6
Flow q = (CFM) 449

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory __ Unsatisfactory X Describe; The capture is poor with the hood fully open.

Room Rating: Poor; Return air registers and door louver air blow across the face of the hood. Cross drafts with sash closed exceeded 100 FPM on left side.

Hood Location: Poor; In pedestrian path for access to the laboratory.

Recommended Sash Height: 20" to provide face velocities above 100 FPM. (See Comments).

Materials used in hood: Pyridine, Methyl Alcohol, Ethyl Alcohol, Ethyl Acetate, Acetil Nitrile, Formaldehyde.

Comments: This is a clinical chemistry laboratory. The sink in this hood is not hooked up to plumbing. The supply air should be deflected away from the hood face. Otherwise, the 100 FPM face velocity will not be adequate. The hood users should close the hall door and minimize pedestrian traffic when the sash is at working height. This room was under negative pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 302 Location: SE Corner next to door. Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
138	150	95
100	80	70
120	120	120

Sub Total 993 Number of data points 9

Avg. Face Vel.(fpm) 110
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 28.5 Width =l (in.) 39
Conversion sq. ft. 144 Area =a (sq. ft.) 7.7
Flow =q (CFM) 851

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

480	480	430

Sub Total --- 1,390 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 463
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.6
Flow q = (CFM) 752

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory __ Describe; The capture appeared to be adequate, however, it was much more uniform with the sash reduced to 20" height.

Room Rating: Poor; Located between an open hall door and a half open interconnecting door to Room 304. Face cross drafts greater than 40 FPM.

Hood Location: Poor; The hood is in path of pedestrian access to this room.

Recommended Sash Height: 20" for face velocities above 150 FPM.

Materials used in hood: Benzene, Hexane, Acetone, Ethyl Ether.

Comments: This is the Instrument Laboratory. The hall door should be kept closed to reduce cross drafts when this hood is in use. There are 3 additional local free-standing local exhaust pickup above individual instruments. They ranged from 130 to 200 FPM capture at their faces, however, capture velocities at the instruments was less than 10 FPM for the AA and the GC by the door. The other GC had a capture velocity around 100 FPM at the point of emission. These hoods were ducts placed above the heated emission source, therefore, capture would be enhanced some by the rise of the hot exhaust gases. Whether this would be offset by the turbulence of heated exhaust air is uncertain. This room was under negative pressure w.r.t. the adjoining lab room 304.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room 304 Location South East Corner next to door. Hood # UK.

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements

40.	50.	65.	-10
40.	40.	50.	25.
20.	30.	30.	30.

Sub Total 410 Number of data points 12

Avg. Face Vel. (fpm) 34

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (±) 10 fpm from the average.)

Height=h (ft.) 2.5 Width =l (ft.) 7.33
Conversion sq. ft. 1.0 Area =a (sq. ft.) 18.3
Flow =q (CFM) 626

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

170 170 210 180

Sub Total --- 730 Number of data points 4

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 182
Height h= .5 Width = l (same as above)
Conversion to sq. ft. 1 Area a =lx h=(sq. ft.) 3.6
Flow q = (CFM) 655

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory __ Unsatisfactory X Describe; Turbulence was very heavy in the upper right corner with negative airflow. The large amount of materials stored in this hood contribute to this problem.

Room Rating: Poor; Replacement air register blows across face of hood. Cross drafts of face fluctuated between 5 and 30 FPM.

Hood Location: Poor; In path of pedestrian traffic to this laboratory.

Recommended Sash Height: 12" for 100 FPM or 14" for 80 FPM face velocities.

Materials used in hood: Benzene, Acetone, Hexane, Ethyl Ether.

Comments: This is the trace analysis laboratory. This hood was observed during two laboratory procedures commonly conducted with benzene; MOCA clean up and washing glasswear. See personal and area monitoring results elsewhere in this report. It was observed that a passerby even with the sash at 20" height would create substantial dragout from the hood sink with cross drafts of 90 FPM. This facility should be improved for the application observed. See Report Discussion. This room was under positive pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 304 Location: In farthest corner from door NIOSH 03087

Type of hood: Standard__ Auxillary Air__ Other: Blow Down Hood

Flow with sash full open.

Face Velocity Measurements		
16	16	16
10	10	10
35	35	35

Sub Total 183 Number of data points 9

Avg. Face Vel.(fpm) 20
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (±) 10 fpm from the average.)

Height=h (in.) 21.25 Width =l (in.) 22.5
Conversion sq. ft. 144 Area =a (sq. ft.) 3.3
Flow =q (CFM) 67

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

120	55	55

Sub Total --- 230 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 76
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 0.9
Flow q = (CFM) 71

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory__ Describe; The flow pattern was acceptable after removing the nitrogen cylinder cap from the face of the hood.

Room Rating: Ideal; There were no measurable cross drafts.

Hood Location: Ideal; Located in the back corner of the lab.

Recommended Sash Height: 6" will provide a 60 FPM face velocity.

Materials used in hood: Benzene, Acetone, Hexane, Ethyl Ether.

Comments: Trace analysis lab blowdown hood - used to evaporate samples by bubbling nitrogen through them. While the face velocities and observed capture efficiency appear to be inconsistent, it is noted that there was no measurable cross draft. Pedestrians or operator movements beyond those observed would certainly overcome the capture ability of this system. The sash should be kept below 6" when not actually working in the hood. This room was under positive pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 402 Location: Outside wall opposite door. Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
80	80	100
80	80	100
80	80	100

Sub Total 780 Number of data points 9

Avg. Face Vel.(fpm) 86

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (±) 10 fpm from the average.)

Height=h (in.) 25.5 Width =l (in.) 47.5
Conversion sq. ft. 144 Area =a (sq. ft.) 8.4
Flow =q (CFM) 728

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

335 335 335

Sub Total --- 1,005 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 335
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.9
Flow q = (CFM) 663

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory __ Describe; Flow acceptable, however, baffel adjustment was needed to even flow across the face.

Room Rating: Poor; Cross drafting at upper left corner from air supply register 50 FPM.

Hood Location: Good; In corner of room with no pedestrian traffic other than operator.

Recommended Sash Height: Not restricted if return air draft is diverted and flow balanced.

Materials used in hood: Toluene, MEK, 2-ethoxy ethanol.

Comments: This room is an animal exposure lab. The hood is used to generate animal and human exposure chamber concentrations. This room has four animal exposure chambers which are exhausted outside. It also has two local conical exhausts, one over the cylinder of 10% methyl bromide in air and another over a work bench. These hoods provide less than 50 FPM at their face. Based on a smoke test, the cylinder valve was exhausted adequately. However, the bench hood was 20" above the work surface. Smoke tube tests showed no evidence of capture at the work surfaces. This room was under negative pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 424 Location: Between door and air supply. Hood#

Type of hood:Standard X Auxillary Air__ Other:_____

Flow with sash full open.

Face Velocity Measurements		
55	55	55
62	62	62
62	62	70

Sub Total 545 Number of data points 9

Avg. Face Vel.(fpm) 60

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (±) 10 fpm from the average.)

Height=h (in.) 31 Width =l (in.) 70
Conversion sq. ft. 144 Area =a (sq. ft.) 15.0
Flow =q (CFM) 912

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

Sub Total --- 0 Number of data points 3

(UNABLE TO COMPLETE SASH WAS INOPERATIVE. Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 0
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 2.9
Flow q = (CFM) 0

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory__ Unsatisfactory__ Describe;

Room Rating: Poor; Hood between the door and the return air register. Likely to cause cross drafting.

Hood Location:_____

Recommended Sash Height: (Not recorded)

Materials used in hood:_____

Comments: This hood was not in use at the time of the survey. It was in need of repairs. The sash glass and runner were broken. Therefore, the survey could not be completed. It is noted, however, that the face velocities are below the recommended levels even for Ideal operating conditions. This unit should be evaluated after repairs are made.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 430 Location: Farthest corner from door. NIOSH 16788

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
200	225	225
175	175	185
175	175	185

Sub Total 1,720 Number of data points 9

Avg. Face Vel.(fpm) 191
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 27 Width =l (in.) 38.5
Conversion sq. ft. 144 Area =a (sq. ft.) 7.2
Flow =q (CFM) 1,379

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

480	480	430

Sub Total --- 1,390 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 463
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.6
Flow q = (CFM) 743

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory __ Describe;

Room Rating: Ideal; Supply air enters from opposite side of room at ceiling height.

Hood Location: Ideal; Back corner of room. No unnecessary pedestrian traffic.

Recommended Sash Height: No limitations.

Materials used in hood: Not in use.

Comments: This hood was originally used for radioisotopes, however, it does not have a dedicated use at this time. This hood would not require such high face velocities to perform well. The room is under negative pressure with respect to hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 449 Location: South Wall Hood# UK

Type of hood: Standard__ Auxillary Air__ Other:_____

Flow with sash full open.

	Average Face Velocity Measurements		
(fluctuating 20 to 50 FPM)	40	40	40
	55	40	55
	70	40	55

Sub Total 435 Number of data points 9

Avg. Face Vel.(fpm) 48

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 32 Width =l (in.) 71
Conversion sq. ft. 144 Area =a (sq. ft.) 15.7
Flow =q (CFM) 762

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

275 275 275

Sub Total --- 825 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 275
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 2.9
Flow q = (CFM) 813

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory__ Unsatisfactory X Describe; Turbulence caused by fluctuating airflow and cross currents.

Room Rating: Poor; Cross currents range from 10 to 50 FPM at the face with the sash closed.

Hood Location: Poor; Between two doors and the narrow alternate pedestrian pathway will invite frequent traffic.

Recommended Sash Height: 20" will provide 80 to 100 FPM velocities.

Materials used in hood: Industrial solvents such as tetramethyl benzene, O-toluodine, 1- and 2-tritropropane.

Comments: This is a toxicology laboratory. This hood is used in an animal metabolite study. Animals are given oral dose and excretion collected. Animal chamber air expelled through building vacuum system. The apparatus partially obstructs flow on right side of hood.

The fluctuating airflow would not provide a study turbulent-free capture pattern. The reason should be sought and corrected if this hood is to be used with open toxic chemical. This room was under negative pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 449 Location: West Wall NIOSH 16624

Type of hood: Standard__ Auxillary Air__ Other:_____

Flow with sash full open.

	Face Velocity Measurements		
(double vertical	138	165	138
sash half opened)	160	155	138
	35	138	44

Sub Total 1,111 Number of data points 9

Avg. Face Vel.(fpm) 123

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 21 Width =l (in.) 63
Conversion sq. ft. 144 Area =a (sq. ft.) 9.1
Flow =q (CFM) 1,134

	Face Velocity Measurements		
(double vertical	80	110	138
sash fully open)	90	110	120
	35	80	20

Sub Total 783 Number of data points 9

Avg. Face Vel.(fpm) 87

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 40 Width =l (in.) 63
Conversion sq. ft. 144 Area =a (sq. ft.) 17.5
Flow =q (CFM) 1,522

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

138 335 225 000

Sub Total --- 698 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 232
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 2.6
Flow q = (CFM) 610

Room: 449 Location: West Wall - CONTINUED NIOSH 16624

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face: Satisfactory__ Unsatisfactory X Describe; Both ends flow is obstructed by glass chromatography chambers sitting on the work surface.

Room Rating: Poor; The cross currents with sash closed fluctuated wildly and as high as 50 and 70 FPM.

Hood Location: Poor; In pathway with narrow passage in front of the hood face.

Recommended Sash Height: Unrestricted - with operational changes noted below.

Materials used in hood: Ethyl lacetate, Methanol, Benzene, Hexane, other solvents.

Comments: This is a toxicology lab. This hood is used for low-pressure chromatograhy.

Considering the wide range of the sash, this hood performed well. However, the laboratory instruments and equipment sitting on the work surface prevented its properly controlling emissions. Placing these items on elevated racks would allow airflow underneath and should improve the control pattern. The deflection of the return air cross draft is necessary to have effective control at the face of the hood.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 452 Location: South Wall Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
125	125	138
120	125	138
125	138	125

Sub Total 1,159 Number of data points 9

Avg. Face Vel.(fpm) 128
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 24 Width =l (in.) 47
Conversion sq. ft. 144 Area =a (sq. ft.) 7.8
Flow =q (CFM) 1,008

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

410	410	410

Sub Total --- 1,230 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 410
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.9
Flow q = (CFM) 802

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory __ Describe;

Room Rating: Poor; cross drafts measured at the face at 40 FPM.

Hood Location: Poor

Recommended Sash Height: Unrestricted.

Materials used in hood: 8-methoxy psorlan (8-MOP), CO, Oxygen, Mixing agents.

Comments: This room also has a 15" by 15" canopy hood 38" above the work bench with a face velocity of 40 FPM. This provides no capture velocity at the working surface.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 460 Location: SW Corner (Perchloric Acid) Hood)#UK

Type of hood:Standard__ Auxillary Air__ Other: Perchloric Acid Hood

Flow with sash full open.

Face Velocity Measurements		
240	225	200
200	200	125
240	120	110

Sub Total 1,660 Number of data points 9

Avg. Face Vel.(fpm) 184
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 29 Width =l (in.) 86.5
Conversion sq. ft. 144 Area =a (sq. ft.) 17.4
Flow =q (CFM) 3,213

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)
800 860 620
Sub Total --- 2,280 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 760
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 3.6
Flow q = (CFM) 2,739

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory__ Describe; Flow rates were partially blocked by trays in the lower right quarter.

Room Rating: Ideal; Lateral cross drafts were less than 10 FPM.

Hood Location: Ideal; In the corner.

Recommended Sash Height: Unrestricted

Materials used in hood: Perchloric acid other acids exclusively.

Comments: This is a perchloric acid hood with wash down. It has a broken sash glass. The flow rates are excessive.

This room is under negative pressure w.r.t. the hall.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 460 Location: Center of room. Hood# UK

Type of hood: Standard X Auxillary Air __ Other: _____

Flow with sash full open.

Face Velocity Measurements		
40	40	35
40	44	35
40	44	10

Sub Total 330 Number of data points 9

Avg. Face Vel.(fpm) 37

(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (+) 10 fpm from the average.)

Height=h (in.) 33 Width =l (in.) 42.5
Conversion sq. ft. 144 Area =a (sq. ft.) 9.7
Flow =q (CFM) 355

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

155 175 150

Sub Total --- 480 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)

Avg. Vel. (fpm) 160
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 1.7
Flow q = (CFM) 283

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory __ Describe; A trash bag was restricting flow in the lower right corner.

Room Rating: Good; Cross currents were less than 25 FPM at the closed sash.

Hood Location: Good; Location discourages pedestrian traffic when hood is in use.

Recommended Sash Height: 14" provides 80 FPM face velocities.

Materials used in hood: Teratogenic drugs.

Comments: This hood is used for teratogenic drug testing. Drugs are mixed and Drosphila Flies are used as indicator organisms. The flies are being tested with known teratogens.

HOOD FACE VELOCITY AND FLOW RATE CALCULATIONS

Room: 461 Location: Wall adjacent to door. Hood#

Type of hood: Standard X Auxillary Air__ Other:_____

Flow with sash full open.

Face Velocity Measurements		
480	24	24
335	20	10
390	20	10

Sub Total 1,313 Number of data points 9

Avg. Face Vel.(fpm) 145
(Under ideal to good physical conditions should be 80 - 100 fpm and should not vary more than (±) 10 fpm from the average.)

Height=h (in.) 31.5 Width =l (in.) 62
Conversion sq. ft. 144 Area =a (sq. ft.) 13.5
Flow =q (CFM) 1,978

Flow with sash at 6 in. Measured Velocities (fpm) and their (Sum)

	150	90	70	000

Sub Total --- 310 Number of data points 3

(Readings should be at least 2 but not more than 3 times the velocity with the sash fully raised.)
Avg. Vel. (fpm) 103
Height h= 6 Width = l (same as above)
Conversion to sq. ft. 144 Area a =lx h=(sq. ft.) 2.5
Flow q = (CFM) 266

OBSERVATIONS AND COMMENTS

Titanium Tetrachloride indication of flow patterns at hood face:
Satisfactory X Unsatisfactory__ Describe; This is a special application (see notes below).

Room Rating: Good; Drafts were less than 10 FPM at the face with the hood off.

Hood Location: Poor (could pass for present use, but not for general use as fume hood).

Recommended Sash Height: The 23" sash normally used appears to provide about 100 FPM on the left and 50 FPM in front of the instrument.

Materials used in hood: Toluene, Methanol, Carbon Dioxide with Carbon 14.

Comments: This hood used to enclose a Packard 3306 sample oxidizer. The instrument fills 2/3 of the face of the hood. The instrument has a built-in emissions control system which discharges emission wastes to the hood. Smoke tube observations indicate the system effectively captures air at the emission sources. Four additional exhaust outlets are used for disecting on benches. Each has a damper control; the slots are around 4" by 12" and not flanged. All showed smoke tube capture except the farthest one which is on a small branch duct. This should be redesigned to equalize flow. Flanges should be added to each hood to extend the effective capture radius. Reportedly not all of these dampers are opened for any one activity. This is certainly appropriate and should be a standard procedure.

APPENDIX 2

Figure 1

Example EPA Form

Date	Man Rdg.	Damper Position	RPM	Ave. Face Vel.	Sash Hgt.	Filter SP Inlet	Filter SP Outlet

Filter Chgd: Previous Filter Chg:

Filter: Name-
Type-

Pre Filter: Name-
Type-

Duct
Transition PS
Fan Blade

Material | Condition

Exhaust Fan Data:

Name of Fan: Model No: Size

Size of Motor: RPM:

Sp: Inlet - Outlet -

Number of Belts Size:

Supply Fan Data:

Name of Fan: Model No: Size

Size of Motor: RPM:

Sp: Inlet - Outlet -

Number of Belts Size:

Accessories:
Steam Bath
Wash Down

Date:

EPA HOOD CARD

Code No.

Organization
Person i/c
Materials Used in Hood

Hood Data
Mfg:
Type:
Sashes:
Slots:
By-Pass:
Lighting:
General Physical Condition:

Work Surface
Material:
Recessed:

Interior Surface
Material:

How Operated

Switch Location
Other switches on system
Fan location
Fan identified

Other Hoods on This System
Dampers
Manual
Other

Filters Type, manometer, tickled

Use of Room
Person Interviewed
Room Racing
Hood Location

Recommended Sash Height

Labelled:

Example EPA Form

Bruce G. C[illegible]

LABORATORY CHEMICAL FUME HOOD INSPECTION

DATE OF PREVIOUS INSPECTION | DATE

THIS INSPECTION PERFORMED BY (Name)

LOCATION OF HOOD

TYPE OF HOOD

☐ Standard ☐ Auxiliary Air supply ☐ Other (Specify)

GENERAL TOXICITY RATING OF MATERIAL USED IN HOOD

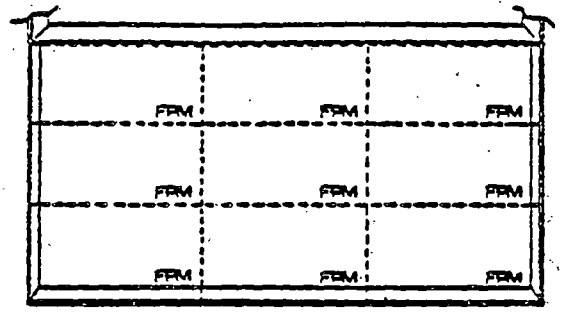
☐ Low (STEL ≥ 1,000 PPM) ☐ Medium ☐ High (STEL ≤ 10 PPM)

CROSS SECTIONAL AREA AT FACE

Height: _____ feet x Width: _____ feet = _____ feet ^{2}.

AIR VELOCITY READINGS

(Readings are to be taken at each of the prescribed frontal locations.)

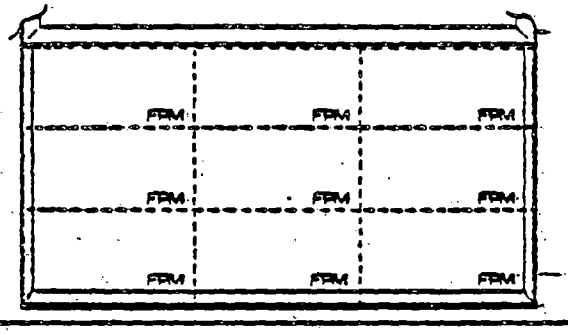


Exhaust off, sash fully raised.

(Exhaust flow value equal to zero CFPM.)

Average value _____ FPM.

(Value should not exceed 20 FPM.)



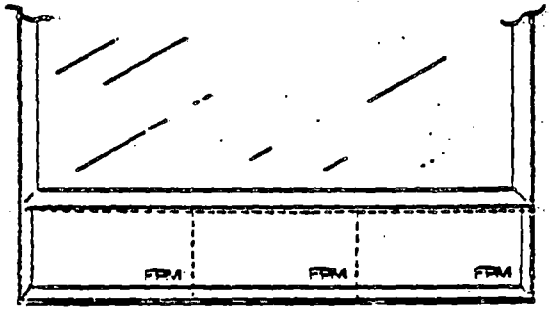
Exhaust on, sash fully raised.

(Readings may not vary more than ± 10 FPM from average value.)

Average value _____ FPM.

(Value should be 60–100 FPM.)

Exhaust flow value _____ CFPM.



Exhaust on, sash 6 inches above work surface.

(Readings shall be at least 2 but not more than 3 times the face velocity when sash was fully raised.)

Average value _____ FPM.

Exhaust flow value _____ CFPM

EXHAUST READING WITH SASH CLOSED

Should be essentially the same readings as those obtained with sash fully opened and sash 6 inches above the work surface.

Exhaust flow value _____ CFPM.

TITANIUM TETRACHLORIDE INDICATION OF FLOW PATTERNS AT HOOD FACE.

☐ Satisfactory flow patterns evident.

☐ Unsatisfactory (Describe):

ONE-MINUTE SMOKE BOMB DISCHARGE.

☐ Effective smoke removal with sash fully raised.

☐ Effective smoke removal with sash 6 inches above work surface.

☐ Effective smoke removal with sash closed.

☐ If unsatisfactory, describe: _____

APPROVAL

SIGNATURE | DATE

☐ This hood is found to be acceptable for use with materials of the general toxicity rating as specified above.

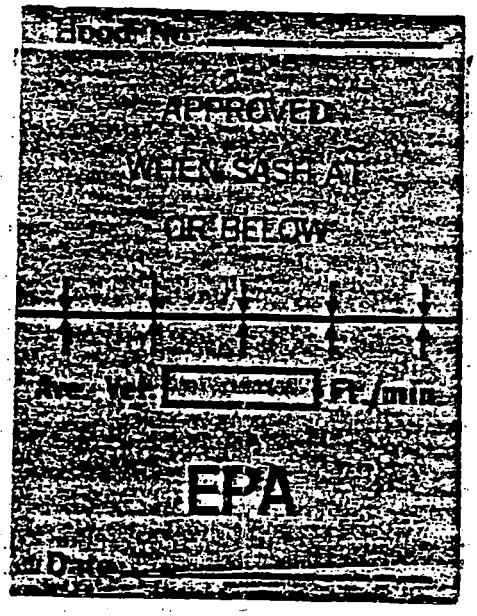
☐ This hood has been found UNACCEPTABLE.

Form SCA-283 (7/79) USDA-SEA

Appendix 2

Figure 2

Example EPA Fume Hood Sash Height
Certification Sticker



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