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Albert Einstein Medical Center
Philadelphia, Pennsylvania

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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, technical and consultative assistance 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.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Calvin K. Cook of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by John Palassis, Education and Information Division. Desktop publishing by Juanita Nelson.

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Health Hazard Evaluation Report 97–0049–2650
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SUMMARY

In December 1996, the National Institute for Occupational Safety and Health (NIOSH) received a Health Hazard Evaluation (HHE) request from employees in the Pathology Laboratory at the Albert Einstein Medical Center located in Philadelphia, Pennsylvania. The request concerned laboratory workers who reported symptoms of fatigue, headaches, dizziness, skin rash, and respiratory and eye irritation believed to be caused by exposure to laboratory chemicals and diesel exhaust emissions from the ambulance bay. NIOSH investigators conducted an industrial hygiene investigation of the laboratory on May 5-7, 1997, and monitored total hydrocarbons, ethylene oxide (EtO), carbon monoxide (CO), carbon dioxide (CO_2), total respirable particulates, temperature and relative humidity. The Chemical Hygiene Plan, material safety data sheets (MSDSs), and all manufacturers' information for laboratory and office equipment were reviewed to identify potential sources of airborne contaminants (i.e., ozone from laser printers). The heating, ventilating, and air-conditioning (HVAC) system and laboratory fume hoods were evaluated for deficiencies and potential entrainment of outdoor air contaminants.

Area air sampling results for individual hydrocarbons (ethanol, isopropanol, and acetone) were well below their respective exposure limits. Ethylene oxide was not detected. Twenty-four hour monitoring for CO concentrations peaked at 6 ppm, below the NIOSH ceiling concentration of 200 ppm, and CO_2 concentrations ranged up to 500 parts per million (ppm), below the 800 parts per million (ppm) guideline recommended by NIOSH investigators for indoor environments. Respirable particulate concentrations ranged up to 0.04 milligrams per cubic meter (mg/m^3), well below the Environmental Protection Agency's (EPA) ambient air quality standard of 0.150 mg/m^3. Temperature and relative humidity levels were within the American Society of Heating, Refrigeration and Air-Conditioning Engineer's (ASHRAE) thermal comfort guidelines for optimal and acceptable ranges for building occupants. Anemometer measurements determined that capture velocities on some fume hoods were not within the acceptable criteria of 80-120 feet per minute (fpm).

Air contaminants measured during the evaluation were below concentrations typically expected to cause the worker complaints. However, ventilation deficiencies, along with fire prevention and general laboratory safety concerns, were observed by NIOSH investigators. Recommendations are offered in this report to improve laboratory safety and to evaluate worker exposures to formaldehyde and potentially other solvents emanating from lab analytical instruments.

Keywords: SIC 8071 (Medical Laboratories), indoor environmental quality, IEQ, eye irritation, respiratory irritation, HVAC, chemical fume hoods, hydrocarbons, ethylene oxide, diesel exhaust.

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INTRODUCTION

In December 1996, NIOSH received a Health Hazard Evaluation (HHE) request from a group of Pathology Laboratory employees at the Albert Einstein Medical Center concerning health complaints of fatigue, headaches, dizziness, skin rash, and respiratory and eye irritation believed to be associated to exposures to laboratory chemicals and diesel exhaust emissions. Lab workers, as well as others throughout the hospital, complained about sporadic exposures to diesel exhaust entering the hospital's ventilation system. In response to the request, on May 5-7, 1997, NIOSH industrial hygienists conducted an industrial hygiene investigation of employee health complaints. The investigation included environmental monitoring for hydrocarbons, ethylene oxide (EtO), carbon monoxide (CO), carbon dioxide (CO_2), total respirable particulates, temperature and relative humidity. The laboratory's chemical fume hoods and heating, ventilating, and air-conditioning (HVAC) system were evaluated for deficiencies.

BACKGROUND

Facility Description

The Albert Einstein Medical Center is a six-story, 500-bed hospital located in an urban/commercial setting. The 31,000 square-foot Pathology laboratory is located on the lower level of the Tower Building. The Pathology laboratory consists of Hematology, Histology, Cytology, Chemistry, Special Chemistry, Blood Bank, and Electron Microscopy areas. A laboratory staff of about 80 workers (including medical technologists and technicians) generally worked 8-hour shifts each day that included performing routine pathology analyses on biological specimens.

Ventilation Description

The heating, ventilating, and air-conditioning (HVAC) needs of the Pathology laboratory are served by a single-ducted, constant volume system with a *design* airflow capacity of 57,000 cubic feet per minute (cfm). Ventilation for the Pathology lab (the induction of outdoor air) is provided by air-handling unit (AHU) #4 located in a mechanical room on the third floor. The air intake for this AHU, located on the second level and facing east of the building, had a pneumatically controlled damper set to provide 100% outdoor air with no recirculation. Heating is provided by steam coils inside the AHU. Cooling was provided by a 600 ton chiller located at a nearby centralized physical plant. The air filtration system consists of pleated bag filters that include prefilters with an efficiency of 50% and final filters with an efficiency of 95%. Prefilters were changed every two months while primary filters were changed every six months. All exhaust stacks serving the laboratory's biological safety cabinets and chemical fume hoods were ducted to the outdoors through vents on the fourth, fifth, and eighth floors that faced west of the building. The HVAC system has the capacity of humidifying but was reportedly out of service during the survey. General inspection and maintenance on the HVAC system was reportedly performed every two months when prefilters were changed. Chlorine packets were present in the AHU's condensate pan to control growth of microorganisms. There were 2 biological safety cabinets and 13 chemical fume hoods (7 conventional and 6 slotted) present in the Pathology lab.

EVALUATION METHODS

On May 6, 1997, air samples were collected for hydrocarbons and ethylene oxide (EtO), and a series of real-time measurements for CO, CO_2, total respirable particulates, temperature and relative humidity were made during the morning and afternoon hours. The HVAC system serving the Pathology laboratory was evaluated with respect to its maintenance and performance. The inspection focused on the general cleanliness of the AHU and the location of potential air contaminant sources (i.e., emission stacks) outdoors that might enter the building's air intakes. Using a hot wire anemometer, ventilation measurements were conducted to determine the face velocity of each chemical fume hood throughout the laboratory. The Chemical Hygiene Plan, Hazard Communication Program including material safety data sheets (MSDSs), laboratory safety policies and all manufacturers' information for laboratory and office equipment were reviewed to identify potential sources of machine emissions (i.e., ozone from laser printers). Ambulance traffic was recorded to correlate real-time CO concentrations with activities outdoors.

The following information describes the instrumentation, sampling, and analyses used to measure environmental factors during the survey.

Hydrocarbons: An area air sample for hydrocarbons was collected in each of the Histology, Chemistry, Hematology, Cytology, and Main Lab areas. Air samples were collected on 150-milligram (mg) charcoal tubes, using battery-powered air sampling pumps calibrated at a flowrate of 200 cubic centimeters per minute (cc/min), in accordance with NIOSH method 1500.(1) Two charcoal tube area air samples were submitted and analyzed for qualitative screening.

Ethylene Oxide (EtO): Due to employee concern of potential EtO exposure from a sterilization process located adjacent to the Pathology Lab area, two area air samples for EtO were collected in the Main Lab and one sample was collected in the Central Sterile Supply Department. Air samples were collected on solid sorbent tubes (100 mg hydrogen bromide coated petroleum charcoal), using battery-powered sampling pumps calibrated at a flowrate of 150 cubic centimeters per minute (cc/min). Samples were analyzed according to NIOSH Method 1614, using a gas chromatograph equipped with an electron capture detector.(1)

Carbon Monoxide (CO): Real-time measurements for CO were made in the Main Lab area of the laboratory. Measurements were made using a calibrated Toxilog® Atmospheric Monitor equipped with an electrochemical sensor and datalogging capabilities (range: 0-4096 parts per million [ppm]). Since CO is a typical component of diesel exhaust emissions, it was measured during the evaluation to indicate the presence of exhaust emissions in the laboratory.

Carbon Dioxide (CO_2): Carbon dioxide is a normal constituent of exhaled breath and room air and, when measured, can be a used to evaluate adequate quantities of outside air introduced into an occupied indoor space. Real-time CO_2 concentrations were measured using a Gastech Model RI-411A portable CO_2 meter. This portable, battery-operated instrument monitors CO_2 (range 0 to 4975 ppm) by non-dispersive infrared absorption with a sensitivity of 25 ppm. Instrument zeroing and calibration were performed before and after use.

Total Respirable Particles: In a previous NIOSH investigation of a similar laboratory, respirable particulates were related to worker health complaints.(2) Therefore, during this investigation real-time respirable particulate concentrations also were measured by using a GCA Environmental Instruments Model RAM-1 monitor. This portable, battery-operated instrument assesses changes in airborne particle concentrations via an infrared detector, centered on a wavelength of 940 nanometers (nm). At a flowrate of 2 liters per minute (lpm), indoor air is sampled first through a cyclone preselector, which passes through the detection cell, operating on a 0-2 milligrams per cubic meter (mg/m^3) range with a 32-second time constant that yields a resolution of 0.001 mg/m^3.

Temperature and Relative Humidity: To evaluate thermal comfort of the Pathology Lab, real-time temperature and humidity measurements were made using a Vaisala, Model HM 34, battery-operated meter. This meter is capable of providing direct readings for dry-bulb temperature and relative humidity ranging from -4 to 140°F and 0 to 100%, respectively. Instrument calibration is performed monthly using primary standards.

Ventilation Measurements: Capture velocity measurements were made at the face of each laborator hood using a hot-wire anemometer. Ventilation smoke tubes were used to evaluate airflow patterns at laboratory entrances to determine whether they were under positive or negative pressure with respect to areas outside the lab.

Symptoms Questionnaire: Copies of a questionnaire were made available to each of the 80 laboratory employees to obtain background and baseline information about worker health complaints, and how they perceived their work environment. For employees who were not present during the site visit, arrangements were made to grant them an opportunity to complete a questionnaire. The questionnaire asked if the employee had experienced symptoms or health conditions believed to be related to their work environment during the past month. The questionnaire also asked about the frequency of occurrence of symptoms reported, types of personal protective equipment (PPE) used, and a description of workplace environmental conditions. The final section of the questionnaire allowed employees to present or discuss other concerns about their health and work environment. Questionnaires were later reviewed and analyzed to determine the prevalence of reported symptoms.

EVALUATION CRITERIA

General

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are the following: (1) NIOSH Recommended Exposure Limits (RELs),[3] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs®),[4] and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).[5] In July 1992, the 11th Circuit Court of Appeals vacated the 1989 OSHA–PEL Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs continue to enforce the 1989 limits. NIOSH encourages employers to follow the 1989 OSHA limits, the NIOSH RELs, the ACGIH TLVs®, or whichever is the most protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values.

A time–weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8– to 10–hour workday. Some substances have recommended short–term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short–term period.

Hydrocarbons

Hydrocarbons describe a large class of chemicals which are organic (i.e., containing carbon) and have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. These compounds are emitted in varying concentrations from numerous indoor sources including, but not limited to, carpeting, fabrics, adhesives, solvents, paints, cleaners, waxes, cigarettes, and combustion sources, and laboratory chemicals.

Research suggests that the irritant potency of hydrocarbon mixtures can vary. While in some instances it may be useful to identify some of the individual chemicals which may be present, the concept of total hydrocarbons has been used in an attempt to predict certain types of health effects.(6) The use of this total hydrocarbon indicator, however, has never been standardized.

Some researchers have compared levels of total hydrocarbons with human responses (such as headache and irritative symptoms of the eyes, nose, and throat). *However, neither NIOSH nor the Occupational Safety and Health Administration currently have specific exposure criteria for total hydrocarbon mixtures in the nonindustrial environment.* Research conducted in Europe suggests that complaints by building occupants may be more likely to occur when total hydrocarbon concentrations increase.(7) It should be emphasized that the highly variable nature of these complex hydrocarbon mixtures can greatly affect their irritancy potential. Considering the difficulty in interpreting total hydrocarbon measurements, caution should be used in attempting to associate health effects (beyond nonspecific sensory irritation) with specific total hydrocarbon levels.

Ethylene Oxide (EtO)

Ethylene Oxide is used as a sterilant gas for heat-sensitive items in the health care industry, and as a fumigant for such items as spices, books, and furniture. The primary mode of exposure to EtO is through inhalation. Because the odor of EtO cannot be detected below about 420 ppm, workers can be exposed to high concentrations of this compound without knowing it.(8) EtO is an irritant of the eyes, respiratory tract, and skin.

Early symptoms of EtO exposure include irritation of the eyes, nose, and throat and a peculiar taste. The delayed effects of exposure include headache, nausea, vomiting, pulmonary edema, bronchitis, drowsiness, weakness, and electrocardiograph abnormalities.(9)

EtO has been shown to be carcinogenic to animals. Inhalation of EtO has induced excess leukemia in female rats and peritoneal mesothelioma and leukemia in male rats. An increase in the number of gliomas, a rare malignant tumor of the central nervous system, was also observed.(10,11) There is also some limited evidence which suggests that workers exposed to EtO may experience an increased risk of leukemia as compared to unexposed workers.(12, 13)

NIOSH recommends that EtO be regarded as a potential occupational carcinogen and that exposure to EtO be controlled to less than 0.10 part per million (ppm) determined as an 8-hour time-weighted average with a short-term exposure limit not to exceed 5 ppm for a maximum of 10 minutes per day.(3) The OSHA PEL for EtO is 1 ppm as an 8-hour TWA concentration, with a STEL not to exceed 5 ppm for a maximum of 15 minutes per day.(5) The ACGIH TLV® is 1 ppm as an 8-hour TWA concentration.(4)

Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials (e.g., diesel fuel). The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, and nausea. These initial symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. Coma or death may occur if high exposures continue.[14]

The NIOSH REL for CO is 35 ppm for an 8-hour TWA exposure, with a ceiling limit of 200 ppm which should not been exceeded.[3] This REL is designed to protect workers from health effects associated with carboxyhemoglobin (COHb) levels in excess of 5%.[14] The ACGIH recommends an 8-hour TWA TLV® of 50 ppm, with a ceiling level of 400 ppm. Currently, the ACGIH has published a notice of an intent to change the TLV to 25 ppm as an 8-hour TWA.[4] The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure. In addition to these standards, the National Research Council has developed a CO exposure standard of 15 ppm, based on a 24-hour per day, 90-day TWA exposure.[15]

Carbon Dioxide (CO_2)

Carbon dioxide is a normal constituent of exhaled breath and room air. When monitored CO_2 can be used as a screening technique to evaluate whether adequate quantities of outside air are being introduced into an occupied space. ASHRAE's most recently published ventilation standard, ASHRAE 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for laboratories and office spaces.[16] Maintaining the recommended ASHRAE outdoor air supply rates when the outdoor air is of good quality, and there are no significant indoor emission sources, should provide for acceptable indoor air quality.

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 parts per million [ppm]). Carbon dioxide concentration is used as an indicator of the adequacy of outside air supplied to occupied areas. When indoor CO_2 concentrations exceed 800 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. It is important to note that CO_2 is not an effective indicator of ventilation adequacy if the ventilated area is not occupied at its usual level.

Temperature and Relative Humidity

Temperature and relative humidity measurements are often collected as part of an indoor environmental quality investigation because these parameters affect the perception of comfort in an indoor environment. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature.[16] Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The American National Standards Institute (ANSI)/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable.[16] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68-74°F in the winter, and from 73-79°F in the summer. The difference between the two is largely due to seasonal clothing selection. In separate documents, ASHRAE also recommends that RH be maintained between 30 and 60% RH.[16,17] Excessive humidities can support the growth of microorganisms, some of which may be pathogenic or allergenic.

RESULTS AND OBSERVATIONS

Industrial Hygiene Evaluation

Air sampling results are presented in Table 1. Based on a qualitative analysis of area air samples, the predominant hydrocarbons were ethanol, isopropanol, and acetone. However, the general room concentrations for these hydrocarbons were very low (8 ppm for ethanol, 0.70 ppm for isopropanol, and trace levels for acetone, each as an 8-hour TWA concentration). These concentrations were well below their respective exposure limits.

The highest CO concentration measured over a 24-hour sampling period was 6 ppm, well below the NIOSH ceiling REL of 200 ppm. Carbon dioxide concentrations were measured up to 450 ppm, within the recommended guideline of 800 ppm for indoor environments. Real-time measurement results for suspended particulates revealed concentrations in the range of 0.02 to 0.04 mg/m^3, below EPA's ambient PM_{10} of 0.15 mg/m^3.[18] Temperature measurements ranged from 70° F to 73°F, and relative humidity measurements ranged from 59% to 68%. In combination, temperature and relative humidity were within ASHRAE's thermal comfort guidelines for optimal and acceptable ranges for building occupants (see Appendix A).

A visual inspection of the exterior and interior of the AHU serving the laboratory showed no signs of standing water, visible microbial growth, debris, damaged insulation, or overloaded air filters. Outdoor air dampers were fully opened and in operable condition. The mechanical room that housed the AHU appeared clean and review of HVAC inspection records indicated a good maintenance program. Outdoor air intakes were not within 50 feet of exhaust terminals or stacks. However, a street was located below the building's air intakes and the ambulance bay was located within 20 feet of the closest air intake.

According to airflow measurements, the laboratory's north and east entrances were under positive pressure. For laboratory ventilation design it is standard practice to provide a negative pressure within the laboratory --with respect to other areas of the hospital-- to control biological and chemical contaminants.

Flammable liquid storage cabinets in the Main lab and Histology area were improperly vented from the top of the cabinets. Instead, they should be vented from the bottom because most chemical vapors are heavier than air and tend to linger near the bottom of storage cabinets. Also, the storage cabinet in the Histology area was not properly grounded to prevent static electricity from causing spark discharges that may ignite flammable or explosive vapors.

Observed on some workers' fingers and hands were stains from using chemical dyes that may contribute to cases of skin rash.

Symptoms Questionnaire

Questionnaire results are shown in Tables 2 and 3. Of the 80 workers employed during the survey, 34 returned questionnaires (a response rate of 43%). The first column of Table 2 shows the type of symptoms reported by workers. The second column shows the percentage of the 34 respondents who reported the occurrence of symptoms while at work on the day of the survey. The most prevalent symptoms reported by the 34 respondents were irritated eyes, sinus congestion, sneezing, mucous membrane irritation, headache, fatigue, and sore throat. The third column of Table 2 shows the percentage of employees who reported experiencing the respective symptoms once a week or more often while at work during the four weeks preceding the survey, and the fourth column shows the percentage of reported symptoms that got better when workers were away from work. The later criterion has, in some industrial hygiene studies, been used to define a work-related symptom, but it is possible that a symptom which does not improve when away from the workplace could also be due to conditions at work. In addition, reported symptoms experienced by workers every or almost every workday included frequent irritated eyes, fatigue, sinus congestion, sore throat, and skin irritation.

Table 3 shows results of employee reports regarding environmental conditions at their workstations on the day of the survey and during the four weeks preceding the survey. The first column presents the workstation conditions. The second column shows the results for the day of the survey. It shows that 53% perceived that there was too little air movement, 41% of the respondents were bothered by unpleasant odors, 41% thought it was too hot, 38% were bothered by chemical odors, and 38% thought the air was too dry during at least part of their workday. The third column shows the responses to the questions about environmental comfort conditions experienced in the laboratory during the 4 weeks preceding the survey. Adverse environmental conditions were considered "frequent" if they were reported to occur at work once a week or more often. The results are generally higher than those shown in the second column for workstation environmental conditions experienced during the day of the survey. Fifty-nine percent of the respondents perceived too little air movement, 56 percent though it was too hot, 56% were bothered by chemical odors, 53% were bothered by unpleasant odors, 50% thought it was too cold, bothered by chemical odors, and 41% thought the air was too dry.

The final section of the questionnaire allowed employees to discuss other concerns about their health and work environment. The issues presented were general concerns about an ongoing yet inherent building design problem where the ambulance bay is in close proximity to the building's air intakes. Although administrative actions (i.e., prohibiting idling engines on the street near air intakes) have been made by management, there were regular exhaust odor complaints by hospital workers. One worker also expressed concern about being chemically sensitized while working with a formalin (37% formaldehyde) solution.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, air contaminant concentrations measured during the evaluation do not support worker health complaints. However, ventilation deficiencies and concerns about fire prevention and general laboratory safety were observed. There is also a need to conduct additional air sampling for formaldehyde and other solvents potentially emanating from lab analytical instruments. The following recommendations are offered.

1. Slotted hoods should be evaluated and modified to improve their efficacy to control chemical contaminants. Installing top and side panels on slotted hoods will improve the capture velocity and save energy. Panels made of Plexiglass® material will allow workers to observe their work while performing tasks under the hood. The overhead canopy hood in the Histology Lab should be modified or extended to better control chemical emissions from analytical instruments. A qualified ventilation engineer should be consulted to implement improvements.

2. The chemical fume hood used in the Electron Microscopy (EM) area is poorly situated (less than 1 foot from an entrance door). Because opening doors can create drafts that can result in the release of air contaminants from the hood (i.e., osmium and arsenic), ANSI recommends locating doors more than 10 feet from any door or doorway (emergency exits excepted), and should not be located on a main traffic aisle. Either the door should remain closed while the hood is being used by a worker, or the hood should be relocated to more than 10 feet away from the door.[19]

3. An individual walking past a hood within 3 feet at a pace of 1 mile an hour (a comfortable walking speed is on the order of 2-3 miles per hour) will exceed the minimum capture velocity of 80 fpm for lab hoods. To prevent pulses of air contaminants from potentially escaping from hoods caused by occupant traffic in the lab, it would be good practice to identify a visible boundary by applying tape on the floor below the hood to establish a work-zone of 3 feet. Workers should be instructed to avoid walking within the established work-zone while a hood is being used by other workers.

4. While disposable latex gloves are commonly known to protect workers from biological agents, they do not provide adequate skin protection against chemical reagents used in the laboratory. Workers who experience skin rash or irritation caused by

chemical exposure should be provided with protective gloves made of nitrile rubber which provides adequate impermeation by many chemicals, particularly formaldehyde.[20] To maintain the dexterity granted by latex gloves to perform intricate laboratory tasks, very thin nitrile rubber gloves are available. Latex rubber gloves are known to cause skin rashes (allergic contact dermatitis) among sensitized health care workers. In those situations where latex gloves remain in use, furnishing hypoallergenic latex gloves to workers should be considered to help alleviate skin problems.

5. To deter motor vehicles from idling engines on the street east of the building, additional "No Parking" signs should be posted that will cover the entire length of the building where air intakes are located. Additional signs stating "No Engine Idling" should also be posted near the ambulance bay. Installing a surveillance camera should be considered if problem continues.

6. Air sampling for formaldehyde is recommended to assess workers' exposures. Although low levels are expected, literature suggests eye and mucous membrane irritation in humans may occur when exposed to formaldehyde concentrations ranging from 0.1 to 0.3 ppm.[9] Further evaluation of solvent vapors emanating from analytical instruments should be done using a real-time gas monitoring instrument (i.e., photoiozing detector). Analytical instruments that indicate release of solvent vapors should be provided with direct exhaust ventilation, in accordance with ANSI standard Z 9.5.[19]

7. For fire prevention, flammable liquid storage cabinets present in the Main lab and Histology area should be vented from the bottom of the storage cabinets, not the top, because most chemical vapors are heavier than air and tend to linger near the bottom. In addition, the storage cabinet in the Histology area should be properly grounded as recommended by the manufacturer and in accordance with OSHA general industry regulation 29 CFR 1910.106.

8. To keep the laboratory under negative pressure as designed, the HVAC system should be balanced to ensure negative pressure is maintained at the east and north entrances of the laboratory.

9. Workers should be made aware not to store unnecessary supplies (i.e., paper, chemical containers) in hoods that may block airflow and reduce hood efficacy.

10. Finally, hospital management should be made aware to comply to all provisions of the Blood borne Pathogen standard (29 CFR 1910.1030) and the OSHA Laboratory standard (29 CFR 1910.1450). Recommended guidelines for laboratories by ANSI, ASHRAE, and NRC should also be considered.

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Table 1
Air Sampling Results
Albert Einstein Medical Center
HETA 97-0049
Sample Date: May 6, 1997

Sample Location	Sample Type	Sampling Time (minutes)	Sample Flow Rate (liters per minute)	Sample Volume (liters)	Concentration (ppm)			
					Ethanol	Isopropanol	Acetone	Ethylene Oxide
Hematology	Area	521	0.200	101	trace	0.03	trace	NA
Histology	Area	508	0.200	98	8	0.7	trace	NA
Main Lab (west)	Area	509	0.200	102	0.06	0.07	trace	ND
Main Lab (east)	Area	508	0.200	99	0.05	0.05	trace	ND
Cytology	Area	485	0.200	95	4	0.20	NA	NA
Central Sterile Supply	Area	477	0.200	90	NA	NA	trace	ND
Minimum Detectable Concentration (MDC)				100	0.01	0.004	0.004	0.01
Minimum Quantifiable Concentration (MQC)				100	0.03	0.014	0.014	0.036
Exposure Criteria								
NIOSH Recommended Exposure Limit (REL)					3300 ppm TWA	400 ppm TWA	250 ppm TWA	<0.10 ppm TWA
OSHA Permissible Exposure Limit (PEL)					3300 ppm TWA	400 ppm TWA	1000 ppm TWA	1 ppm TWA
ACGIH Threshold Limit Value (TLV)					1000 ppm TWA	400 ppm TWA	750 ppm TWA	1 ppm TWA

Abbreviations:
ND = Not detected (less than the MDC)
TWA = Time weighed-average (8-hours)
NA = No sample collected
ppm = parts per million
GA = General area air sample

Trace = Concentration is between the MDC and the MQC.

Table 2
Symptoms Experienced At Work
Albert Einstein Medical Center, Philadelphia, PA (HETA 97-0049)

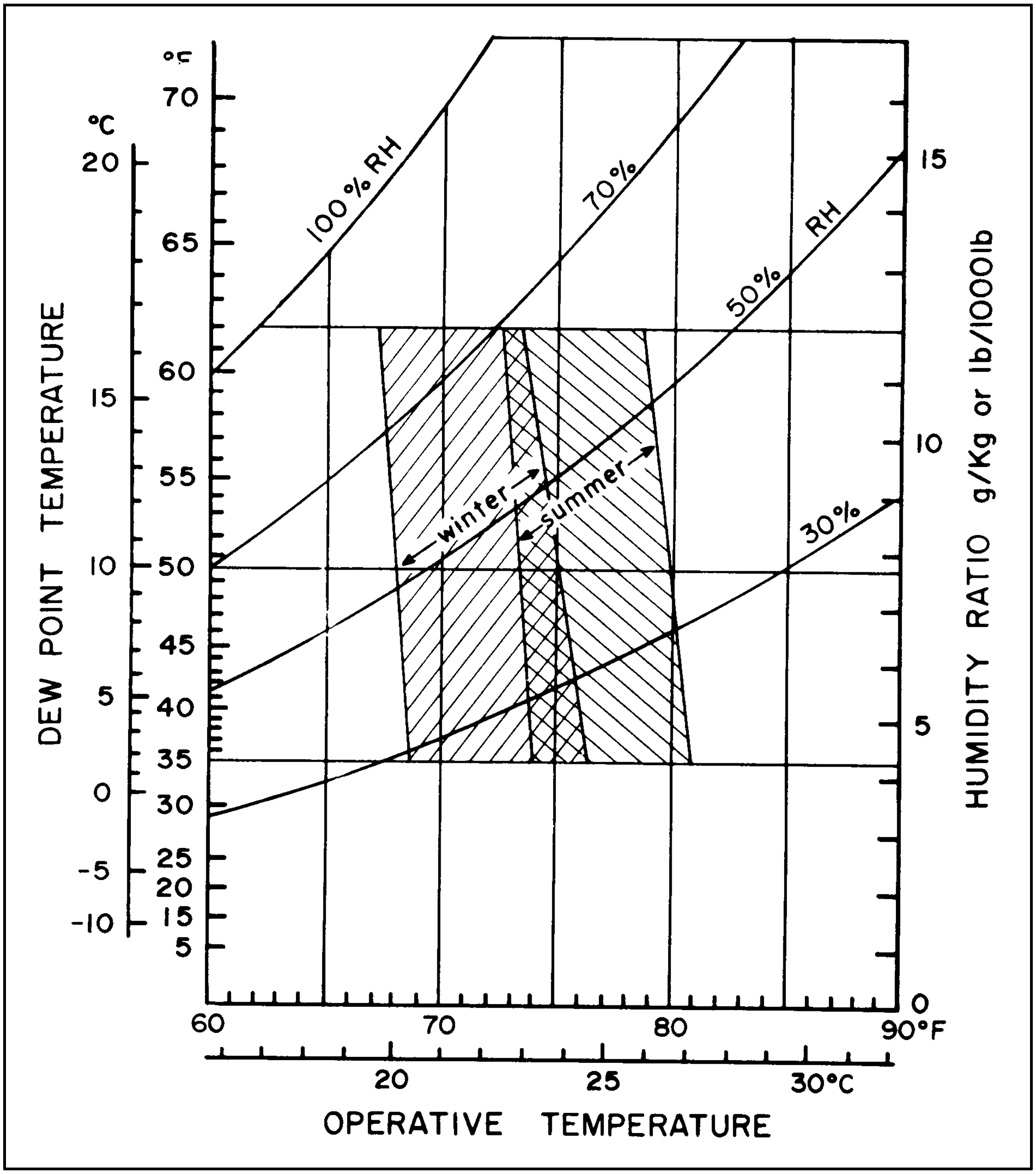
Symptoms Of 34 Workers	Experienced On Day of Survey While At Work (n=34)	Frequently Experienced in Last 4 weeks While at Work (n=34)	Have Frequent Symptoms that Improve When Away from Work (n=34)
Dry, itching, or irritated eyes	44%	38%	24%
Wheezing	0%	12%	3%
Headache	21%	71%	29%
Dry or sore throat	21%	21%	18%
Unusual tiredness, fatigue	21%	47%	21%
Chest tightness	3%	26%	17%
Sinus congestion	38%	68%	20%
Cough	21%	41%	18%
Mucous membrane irritation	26%	38%	21%
Difficulty concentrating	6%	24%	9%
Frequent colds	6%	9%	3%
Dizziness	18%	44%	29%
Shortness of breath	6%	15%	11%
Skin irritation	18%	41%	15%
Sneezing	29%	50%	6%

Table 3
Description Of Workplace Conditions On Day of Survey
Albert Einstein Medical Center, Philadelphia, PA, (HETA 97-0049)

Conditions	Experienced At work During Day of the Survey (34 workers)	Frequently Experienced While at work During previous 4 weeks (34 workers)
Too much air movement	24%	23%
Too little air movement	53%	59%
Temperature too hot	41%	56%
Temperature too cold	29%	50%
Air too humid	15%	21%
Air too dry	38%	41%
Tobacco smoke odors	0%	0%
Chemical odors (e.g., sterilants, reagents, anesthesia, medication, etc.)	38%	56%
Other unpleasant odors (e.g., exhaust fumes, sewer odors, etc.)	41%	53%

Appendix A

Thermal Comfort Chart†
ASHRAE STANDARD 55-1981



† Chart courtesy of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Standard 55-1981, entitled "Themal Environmental Conditions for Human Occupancy."