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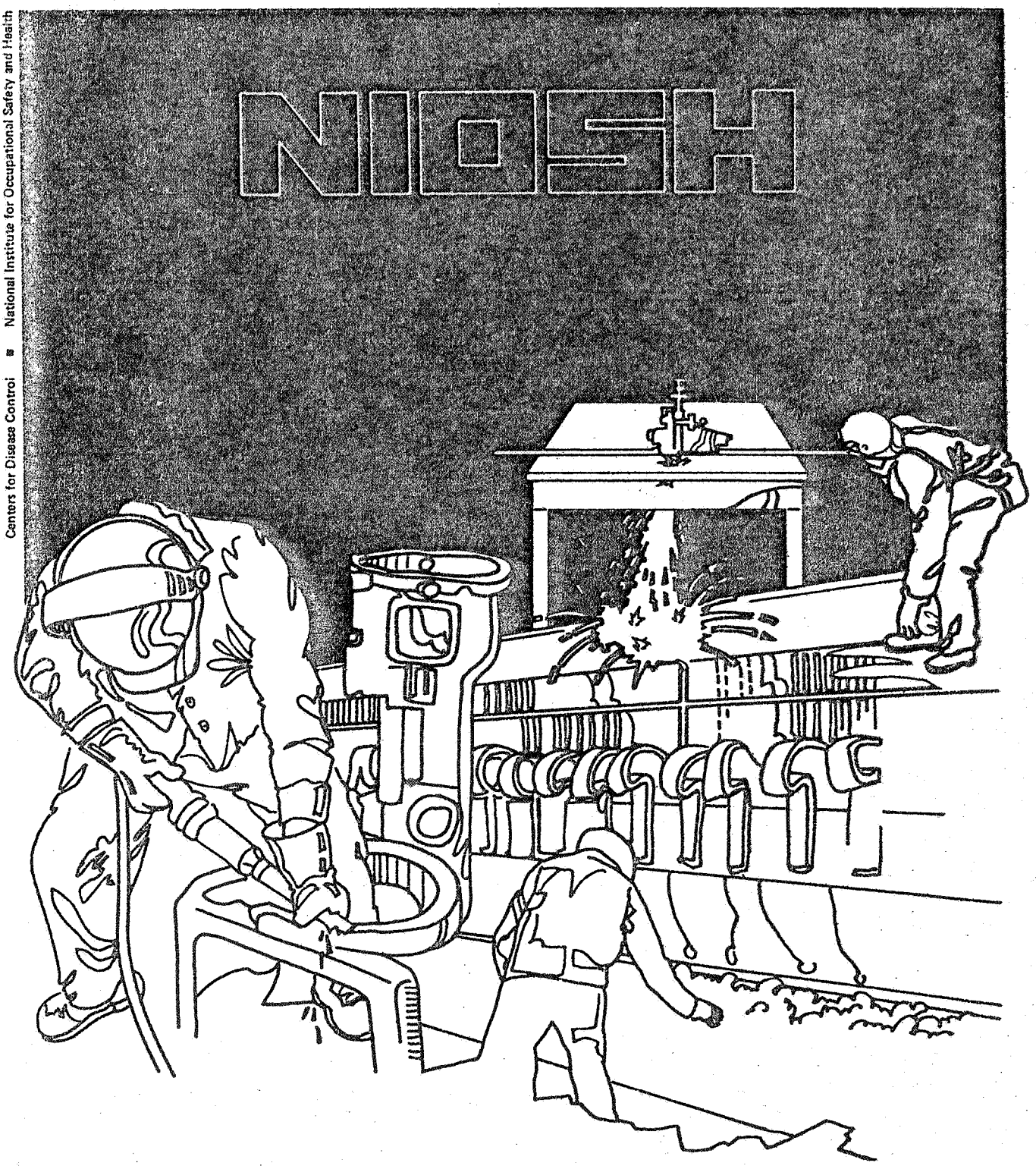

Health Hazard Evaluation Report

HETA 81-422-1387
CALIFORNIA SOCIETY
FOR HISTOTECHNOLOGY
LOS ANGELES, CALIFORNIA

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 nygiene 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.

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I. SUMMARY

In August 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate exposures to formaldehyde, chloroform, xylene, toluene, and methyl methacrylate for histotechnicians employed at various hospitals and private laboratories in the Los Angeles area. The histotechnicians were reporting respiratory and behavioral symptoms which were believed to be associated with workplace exposures.

In October 1981, NIOSH administered a composite medical questionnaire to 94 employees working at 13 worksites throughout the Los Angeles area. All participants were invited to have additional testing of pulmonary function, neurobehavioral function and a dermatological exam on November 6 and 7, 1981 of which 25 participated. More than 80 percent of the workers surveyed reported exposures to xylene, toluene, chloroform, formaldehyde and methacrylate. Fifty-six women working in the same hospitals as the technicians completed the same questionnaire. These results were used as a comparison group.

Significant differences between the histology technicians and controls were found for selected respiratory, dermatologic and neurobehavioral symptoms. Symptoms increased with age and exposure among the technicians, and were temporally related to work periods; none of these effects were found among the controls. Smoking did not explain the increased incidence of symptoms among the technicians. Half of the technicians reported persistence of symptoms after work, and more than one-fourth had sought medical attention for the symptoms.

Based on the medical findings, eight facilities were selected to conduct environmental air monitoring. In May, June and September, 1982 NIOSH conducted environmental air monitoring of several operations (gross tissue dissection, tissue processing, slide preparation and staining) for formaldehyde, chloroform, xylene and toluene. Fifty-two xylene time-weighted average (TWA) air samples were collected at ten worksites. The air concentrations ranged from none detected to 21.8 ppm (parts of a vapor per million parts of air), which is below the NIOSH recommended criterion of 100 ppm. Thirteen ceiling air samples were collected which ranged from 3.9 to 102 ppm. This, also, is below the NIOSH recommended ceiling criterion of 200 ppm. Three TWA toluene air samples were collected from one worksite. The air concentrations ranged from 8.9 to 12.6 ppm which is below the NIOSH recommended criterion of 100 ppm. Eleven TWA chloroform air samples, collected from two worksites, ranged from 0.4 to 6.9 ppm. Nine ceiling air samples were collected and the air concentrations ranged from 2.7 to 19.1 ppm which is above the NIOSH recommended criterion of 2 ppm. Forty-four TWA formaldehyde air samples were collected from nine worksites, and the air concentrations ranged from none detected to 0.7 ppm. Only one air sample detected formaldehyde; thus, a follow-up survey was conducted because irritant symptoms of exposure were experienced by the workers during sampling. Five air samples were collected from the two sites using a different sampling method. The air concentrations ranged from none detected to 1.9 ppm which is above the NIOSH recommended criterion (lowest feasible limit).

Exposures to formaldehyde appears to occur during tissue disposal, formalin preparation, and changing of tissue processor solutions whereas the chloroform exposures occur due to its vaporization from the tissue processor.

On the basis of the environmental data, NIOSH concluded that a health hazard exists to formaldehyde and chloroform under the conditions observed during the surveys. No overexposures to xylene and toluene were measured; however, there were brief exposure during which workers experience irritant symptoms. The medical study found a high prevalence of respiratory and neurobehavioral symptoms and dermatitis among the participating histotechnicians. Recommendations to improve the work environment are included in Section VIII of this report.

KEYWORDS: SIC 8071 (Medical Laboratories) Pathology labs, histology labs, formaldehyde, chloroform, xylene, and toluene.

II. INTRODUCTION

On August 11, 1981 the President of the California Society for Histotechnology, Los Angeles, California-Chapter, requested a health hazard evaluation of histotechnicians working at various hospitals and laboratories in the Los Angeles area. Many of the histotechnicians were reported to have a variety of respiratory and behavioral symptoms (e.g. bronchitis, cold, headache, dizziness) which they believe were associated with their workplace exposures to one or more of the following chemicals: formaldehyde, chloroform, xylene, toluene, and methyl methacrylate.

In October/November 1981, the medical investigator administered a medical questionnaire to histotechnicians working at 13 worksites in the Los Angeles area. Further testing (pulmonary function and neurobehavioral) and a dermatological exam were offered to the participants.

In May, June and September, 1982 NIOSH conducted environmental air monitoring at ten worksites. Environmental results were telephoned to the appropriate laboratory supervisor as soon as they were available. In May, 1983 an interim report was sent to each lab director and supervisor. Each report contained the appropriate environmental results, observations of employee work practices and recommendations for these laboratories.

III. BACKGROUND

The California Society for Histotechnology, Los Angeles Chapter has 100 members, approximately 90 of whom are working at hospitals or laboratories in the Los Angeles area. The histotechnicians were reportedly concerned about poor ventilation and poor safety precautions regarding the use of laboratory chemicals. Many workers reportedly observed numerous health symptoms such as "nose and throat irritation, cough, shortness of breath, irritability, lightheadedness, excessive fatigue and severe cases of contact dermatitis.

In September, 1981 NIOSH contracted with Dr. Kaye Kilburn of the University of Southern California Medical Center, Los Angeles, California to conduct a medical evaluation of histotechnicans. Twelve hospitals and laboratories were included in the NIOSH health hazard evaluation survey. In October/November, 1981, an extensive medical questionnaire was administered to 94 histotechnicans. Based on the information gleaned from these questionnaires, eight facilities were selected to participate in the environmental survey.

JOB DESCRIPTION - HISTOLOGICAL TECHNICIANS

I. GROSS DISSECTION

A. The organ or biopsy is taken from a formalin solution (usually 10%), Zenker fixative or Bouin; however, formalin is most often used.

B. The organ or biopsy is measured, described and sectioned.

C. The sections are immersed for four hours in a formalin solution.

II. TISSUE PROCESSING

A. An automated "tissue processor" is used. It usually has 12 positions (small metallic containers) which contains ethyl alcohol, chloroform (or xylene) and paraffin. The technician hooks small metallic perforated cassettes containing tissue above solutions.

1. Eight of the containers hold graded ethyl alcohol (80%-100%). Alcohol is used to remove water from the tissue since it is not miscible with paraffin.

2. The tissue cassette is immersed in chloroform or xylene to remove ethyl alcohol (referred to as a "clearing agent").

3. The tissue cassette is immersed in paraffin, which firms up the tissue for cutting.

B. The tissue cassette is removed from processor and is "vacuumed" (13 mm Hg) while in molten paraffin. This process removes air from the tissue so that each cell is infiltrated with paraffin. (paraffin at 56-58°C).

III. SLIDE PREPARATION AND STAINING

A. Paraffin embedded tissue blocks are serial sectioned on a microtome (instrument used to thinly slice the embedded tissue).

B. The sections are placed in warm water or a water-gelatin solution after which the tissue sections are placed on slides, to which they may now adhere.

C. The slides are placed in a slide holder (carries approximately 60 slides) and heated in an oven at 60°C. Paraffin is melted off for the most part.

D. The slide holder is dipped in xylene or toluene to remove the paraffin.

E. The slide holder is then dipped into graded ethyl alcohol and rinsed with water.

F. A typical staining procedure is as follows:

1. Slides are briefly immersed in hematoxylin, a "regressive" stain used to intentionally overstain the tissue, e.g. staining bases such as proteins and nuclei.

2. Slides (still in slide holder) are rinsed with water and then excess hematoxylin removed with 1% Hydrogen Chloride in 75% ethyl alcohol.

3. Slides are rinsed with water, "blued" with lithium carbonate for good nuclear detail and then rinsed with water again.

4. Slides are now immersed briefly in eosin, a counterstain and are then rinsed with water followed by a rinsing with 95% ethyl alcohol.

5. Slides are rinsed with water and then immersed in xylene or a toluene/terpineol solution.

6. Slide holder is removed from xylene (preferrably with forceps, however, some technicians may use fingers) so that they may be coverslipped with a xylene or toluene-based mounting resin.

A. Materials and Methods

1. Environmental

Several sampling techniques were used to evaluate the suspected air contaminants which included: formaldehyde, xylene, toluene and chloroform. Personal and/or area air samples were collected to characterize worker exposure. Airborne samples were collected using two sampling techniques: passive dosimeters or a sampling train (calibrated vacuum pump and appropriate collection medium) through which a know volume of air is passed. The following is a description of the sampling and analytical techniques used to characterize the airborne concentrations.

a) Formaldehyde

Two sampling techniques were used to evaluate formaldehyde air concentrations. During the initial survey, air samples were collected using a sampling train and 150 milligram (mg) chromosorb tube. The tubes were subsequently analyzed according to NIOSH Physical and Chemical Analytical Method (P&CAM) number 354 (modified) using a Hewlett-Packard 5711A gas chromatograph with a flame ionization detector. The formaldehyde limit of detection was 10 micrograms (ug) per sample. During the follow-up survey in September, 1982 another sampling method consisting of a one percent sodium bisulfite impinger solutions was used to collect formaldehyde vapors.[13] The samples were analyzed by NIOSH P&CAM method number 125. The analytical limit of detection is two milligrams per sample.

b) Xylene, toluene and Chloroform

Passive dosimeters (3M Brand Organic Vapor Monitor #3500) were worn by employees to determine the airborne concentrations of three organic vapors. Xylene and toluene were sampled using one dosimeter and chloroform was sampled using another dosimeter to prevent chemical interferences during analysis. The monitor is designed to measure average concentrations over a measured time interval of eight hours or less. The monitor is analyzed according to NIOSH P&CAM #127 for charcoal tubes.[13]

In order to determine short-term peak exposures, a sampling train and 150 mg charcoal tube was used to measure airborne concentrations of xylene and chloroform. The charcoal tube was analyzed according to P&CAM #127.

2. Medical

An extensive questionnaire was administered to 90 histology technicians at 13 worksites in Los Angeles County. Six of these had five or more employees; the others were two or three-technician laboratories. The interviewing was done at the workplace, usually during lunch breaks, in groups of two to eight technicians at a time. The questionnaire was a composite made up of 1) the MRC bronchitis questionnaire; 2) an inventory of exposure and work practices in the laboratory; 3) respiratory symptoms associated or following work; 4) a neurobehavioral questionnaire derived from the one used in the survey of polybrominated biphenyls on Michigan farms in 1976 which in turn had been utilized for studies of secondary lead refinery workers and painters; 5) a dermatological questionnaire also derived from the Michigan questionnaire.

On November 6 and 7, 1981 the entire group of 90 histotechnicians were invited to have pulmonary function test, neurobehavioral test and a dermatological examination of which 25 technicians participated. Subsequent to the initial survey, 56 controls consisting of women who work in the same hospitals as the technicians previously studied, were administered the same medical questionnaire by the same interviewer and the same peak flow meter was used.

B. Environmental Criteria:

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for 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 if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a 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 evaluation 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: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

EVALUATION CRITERIA

CONCENTRATION/EXPOSURE PERIOD

Substance	8-Hour TWA	Ceiling	Source
Xylene (ppm)	100	200 (10 min)	NIOSH
(Skin)	100	300	CAL-OSHA
	100	150 (15 min)	ACGIH
Formaldehyde (ppm)	CA	--	NIOSH
	--	2	CAL-OSHA
	--	1 (CA)	ACGIH
Chloroform (ppm)	--	2 (60 min)(CA)	NIOSH
	10	--	CAL-OSHA
	--	10 (CA)	ACGIH
Toluene	100	200 (10 min)	NIOSH
(Skin)	100	500	CAL-OSHA
	--	150 (15 min)	ACGIH

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ppm - parts of contaminant (vapor or gas) per million parts of air by volume.

CA - lowest feasible limit (suspected or confirmed carcinogen based on either (1) limited epidemiological evidence excluding clinical reports of single cases, or (2) demonstration of carcinogenesis in one or more animal species by appropriate methods), use best control technology.

C - ceiling limit, maximum concentration to which an employee may be exposed based on a sampling interval which should not exceed 30 minutes unless otherwise specified.

C. Toxicological Effects

1. Formaldehyde

Formaldehyde has a sharp odor which can be smelled at very low levels (less than one ppm). The first signs or symptoms noticed on exposure to formaldehyde at concentrations ranging from 0.1 to to 5.0 ppm are burning of the eyes, tearing (lacrimination), and general irritation to the upper respiratory passages. Low levels of 0.3 to 2.7 ppm have been found to disturb sleep and to be irritating to a smaller number of people.[1] Higher exposures (10 to 20 ppm) may produce coughing, tightness in the chest, a sense of pressure in the head, and palpitation of the heart.[3-5] Exposure of 50 to 1200 ppm and above can cause serious injury such as collection of fluid in the lungs (pulmonary edema), inflammation of the lungs (pneumonitis), or death.[2]

0.1 - 5.0 ppm
0.3 - 2.7 ppm
10 - 20 ppm
50 - 1200 ppm

Dermatitis due to formaldehyde solutions or formaldehyde-containing resins in a well-recognized problem.[6] After a few days of exposure, a worker may develop a sudden inflammatory (eczematous) reaction of the skin of the eyelids, face, neck, scrotum, and flexor surfaces of the arms. An eczematous reaction also may appear on the fingers, back of the hands, wrists, forearms, and parts of the body that are exposed to the rubbing of clothing. Such rashes sometimes develop after years of asymptomatic exposures.

Recent review[7] of airborne formaldehyde as a factor in indoor air pollution problems suggest a wide spread in individual responses to various formaldehyde levels. A small percentage of the population show a hypersensitivity to even low levels of formaldehyde which can include both upper and lower airway symptoms. The exact mechanisms of this "allergy" are unclear.

Formaldehyde has been shown in a study conducted by the Chemical Industry Institute of Toxicology[8] to induce squamous cell cancer of the nasal sinuses in both Fischer 344 rats and B6C3F1 mice. In a study by New York University, formaldehyde appears to have induced the same type of cancer in Sprague-Dawley rates.[9] Although humans and animals may differ in their susceptibility to specific chemical compounds, any substance that produces cancer in experimental animals, particularly in more than one species, should be considered a cancer risk to humans. Formaldehyde also has demonstrated mugagenic activity in several test systems.[10]

Based on these results, NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen.[1] Safe levels of exposure to carcinogens have not been demonstrated, but the probability of developing cancer should be reduced by decreasing exposure. An estimate of the extent of the cancer risk to workers exposed to various levels of formaldehyde at or below the current 3 ppm Occupational Safety and Health Administration (OSHA) standard[11] has not yet been determined. In the interim, NIOSH recommends that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit. The International Agency for Research on Cancer (IARC) concurs with the recommendations.[12]

2. Xylene

Short-term exposure to xylene vapor may cause irritation to the eyes, mucous membranes and skin; at high concentrations it causes dizziness, staggering, drownsiness and narcosis. Workers exposed to concentrations above 200 ppm complain of anorexia, nausea, vomiting and abdominal pain. The liquid is a skin irritant which causes erythema, dryness, and defatting; prolonged contact may cause the formation of vessicles.[14]

3. Toluene

Short-term exposure to toluene vapor may cause irritation of the eyes, respiratory tract and skin. It may cause fatigue, weakness, confusion, headache, dizziness and drowsiness. Peculiar skin sensitization such as "pins and needles felling" may occur. Liquid toluene splashed in the eye may cause temporary irritation and damage. Repeated or prolonged skin contact with the liquid has a defatting action, causing drying, fissuring and dermatitis.[14]

4. Chloroform

Chloroform is a central nervous system depressant. Short-term exposure to chloroform vapor may cause headache, drowsiness, vomiting, dizziness, unconciousness, irregular heart beat and death. Kidney damage may result from exposure to the vapor. Liquid splashing to the eye causes pain and irritation and repeated skin contact may produce skin irritation.[14]

V. RESULTS AND DISCUSSION

A. Medical:

The histology technicians surveyed included 72 women with a mean age of 41. There were 40 women under the age of 41, with a mean age of 32. There were 32 women over the age of 41 with a mean age of 51.6 years. Thirty-two of the women were non-smokers and 40 were smokers. The distribution of smokers and non-smokers was symmetrical in the two age groups.

Since the preliminary study, 56 controls consisting of women who work in the same hospitals in the Los Angeles County area as the histology technicians have been studied using the same questionnaire, the same interviewer, and the same peak flow meter. The data on these controls has been identified as L.A. Controls N=56.

The exposures by history are to xylene 100%; to toluene 88%; chloroform 81%, and to methacrylate 82%. The latter two are one to eight hours per week. There was exposure to formaldehyde in 98%. Fifty-two percent assisted with sectioning, and 31% did such sectioning in areas where there was simultaneous exposure to solvents. Frequencies of symptoms are presented in Tables 1 through 14. Tables 1 and 2 deal with prevalance of all respiratory symptoms. For comparison, we have listed the respiratory symptoms in Table 1 and 2 in comparison to the recently published data of Deetels et al entitled, UCLA Population Studies of Chronic Obstructure Pulmonary Disease (Chest 78:250, 1980). This was a study of census tract selected people about 75% of whom participated after invitation which was done to study the effects of air pollution in Los Angeles. The control data is for both sexes. The histopathology technician data is for women only. What is notable is a large increase in all symptoms which is most striking among the non-smokers. These control data are also somewhat useful in evaluating the employment related symptoms in Table 2. These frequencies, again, are very high in comparison to Deetels et al, to the Wisconsin Farm control data, or to health inventory data. In Table 1, it is clear that the controls have no important differences from the histology technicians in terms of the past history of respiratory illnesses. In contrast to this in Table 2, it can be seen that the physical symptoms in the technicians greatly exceed those in the controls. The range of difference extends from two-fold to five-fold except for shortness of breath which was not observed at all in the controls. Thus, there is a highly significant difference between the histology technicians and their controls. Table 3 shows a very high frequency of employment related neurobehavioral symptoms. The summary is based on responses which had a frequency of greater than 20%. For comparison we have listed on the right side of the table the frequencies of these symptoms in Wisconsin farm people from the Marshfield area. It should be noted that the Wisconsin group were unexposed while the Michigan farmers were those from the polybromated biphenol quarantined farms. What is striking from this data is that the balance back and forth between smokers

and non-smokers suggest no important effect of cigarette smoking. There is a striking contrast in frequency of symptoms not only to the Wisconsin control farm population, but even to the Michigan PBB exposed population from the quarantined farms. In Table 3, the same differences between the technician and the controls can be seen for the neurobehavioral symptoms with two exceptions, and that is for headache and fatigue where again the technicians exceed the contorls by one and one-half to two-fold. By preliminary chi^2, these frequencies are significant at a level of .001.

Table 4, reviews the frequency of onset all symptoms during work as contrasted to after work with a breakdown between morning and afternoon. The analysis of onset of symptoms and their duration has proved to be the most difficult to administer and the most difficult to understand. Although the technicians had far more symptoms than the controls, there was a similiar pattern of persistence of complaints, particularly after work. It seems notable that of the women (50 percent) who had persistence of symptoms after work, that 27 percent sought medical attention for these symptoms. No great importance could be derived from this comparison except that the questions concerning persistence of complaints are difficult to word, administer and interpret.

The frequency of skin manifestations associated with work coincides with the occasional experience physicians have or have had dealing with these materials. It is clear tha t although gloves can be used for most situations where there is formaldehyde exposure, cover slipping of slides is a precise task for which gloves are ill adapted. Furthermore, many of the gloves dissolve in the solvents, making matters worse.

Table 5 details the comparison of changes in the skin and once again, the striking difference between controls and histology technicians is apparent. Once again, it is in a range from two to ten-fold. We had a consultant dermatologist examine 19 of the women who came into the clinic for follow-up and her findings contrasted with the questionnaire as shown on Table 7. The main import of this table is to show that the tendency was for this sample, at least, to under-report the changes on the questionnaire as contrasted with examination by a dermatologist. The under-reporting was approximately 50%. This gives added confidence to the appraisal of the questionnaire responses for the entire group.

In an effort to determine whether years of exposure had an effect, we divided the population at the mean age of 41 years into two groups with mean age of 32 of 52 years, Table 6. This provided a rough appraisal of an average of eight years of exposure as

a technician to approximately 28 years. We then looked at the controls divided in the same way. The differences between controls and histology technicians is at once apparent, as are some rather striking differences in the frequency of complaints. With one or two exceptions, the age effect was not reflected in the controls. This suggests then that the differences seen in the technicians are more likely to be attributable to duration of exposure rather than to age. Table 8 examines the clustering of complaints per technician in those hospitals or laboratories with three or more technicians. As before, women are examined separate from men because of a clear difference in numbers of complaints per technician which averaged 12 in women and 5 in men out of a total of 50. Several of the hospitals or laboratories have very high complaints per technician. It is interesting that the two newest laboratories, have the lowest frequency.

An invitation was extended to all the 94 particpants to have additional testing of pulmonary function, neurobehavioral function, and a dermatologic exam. Twenty-five histology technicians came in for testing. They were 16 or more hours from their last workplace exposure, Table 9. There were seven who had a post bronchodilator improvement in their forced expiratory flow of 19% or more, reflecting airway hypersensitivity which may have been due to occupational exposure. Four of the 25 persons tested had reduced FEV^1 below 75% of predicted which is interpreted as fixed obstruction of large airways. The results of neurobehavioral testing showed that these 24 women were quite similar to the control populations from Wisconsin and Michigan. The higher educational level and the other differences were not statistically significant.

The effect of dosage or exposure level to formaldehyde and xylene was examined with a number of questions to detail the levels of exposure and then compare the levels for the individuals with their symptom responses. Tables 10 and 11 show such comparisons by hours of direct contact to formaldehyde and then the numbers of slides converslipped (xylene) in the high formaldehyde exposure group. There was a clear gradient in those symptoms from low to mid to high exposures to formaldehyde. Also the gradient was clear between low and high xylene exposures as approximated by the numbers of slides mounted each day. Episodic exposure which was measured by cleaning of the tissue processor or of cassettes had no such effect. Exposure to chloroform and to methacrylate could not be distinguished probably because it was masked by the predominating effects of formaldehyde and the solvents, xylene and toluene.

The last three tables 12, 13 and 14 contrast the symptoms observed in the histology technicians who were women with the control women as to composite groups of 76 and 56 persons and then as matched by age, race and smoking history, the two groups of 46 each. There were no particular differences between the comparison of the total groups and matched groups, but it was clear that frequency of symptoms was significantly higher for the histology technicians in all categories.

This demonstrates that the instrument used which was a composite questionnaire based on previous work at Mount Sinai School of Medicine, does discriminate between exposed and unexposed individuals. Further testing of this questionnaire is proceeding with other occuptional groups.

B. Environmental:

Airborne concentrations of xylene, toluene, chloroform and formaldehyde were measured (see tables 15-26) during the period of May through September, 1982. Each chemical was not necessarily used at each lab. The table listed below is a compilation of all the air samples collected at the ten work sites.

Xylene

Fifty-two xylene TWA air samples were collected from ten labs during the initial survey. The airborne concentrations ranged from none detected to 21.8 ppm which is below the NIOSH recommended criterion of 100 ppm. Thirteen ceiling air samples were collected from the three labs during the follow-up survey and these air concentrations ranged from 3.9 to 102 ppm which is below the NIOSH criterion of 200 ppm. Xylene was observed to be generally well controlled by using the solvent under a portable laboratory hood, canopy exhaust hood or some other local exhaust ventilation system. In most instances, the lids were kept on the solvent trays when not being used. The greatest air concentrations were measured, in two instances, during coverslipping in which the portable lab hood fan was not turned on and where a general room exhaust fan (wall fan) used to remove the xylene vapors as opposed to local exhaust ventilation. Although peak exposures may not have been measured each lab and for each situation, the potential for xylene exposures appears to occur for the following reasons: First, xylene solutions used in the special stains and the tissue processor are occasionally dumped down the drain without running cold water, thus the worker periodically experiences eye irritation. Secondly, the portable fume hood, used to cover slips and store special stains, mounting resins, etc., uses a charcoal filter which is not periodically replaced. Third, the portable fume hood fan may not be turned on while being used because the fan is "too noisy". In addition, the technicians generally do not wear protective gloves for detailed work because the gloves are too clumsy, thus there may be significant dermal exposure. The dermal exposure was observed to occur when the slide holder is removed from xylene with unprotected hands instead of using forceps. Also, the technician handles the slides taken from the xylene with bare hands. It was estimated that an experienced technician may handle 25 slides per hour from start to finish.

Toluene

Three TWA toluene air samples were collected from one laboratory. The air concentrations ranged from 8.9-12.6 ppm, which is below the NIOSH criterion of 100 ppm.

Chloroform

Eleven TWA chlorform air samples were collected from two laboratories. The air concentrations ranged from 0.4 - 6.9 ppm which is below the CAL-OSHA standard of 10 ppm; however, this is greater than the NIOSH recommended criterion which is based on sixty minute sampling periods. Nine ceiling air samples were collected from both labs during a follow-up survey, and these air concentrations ranged from 2.7 to 19.1 which is above the NIOSH recommended criterion and the threshold limit value. Chloroform was only observed to be used in tissue processors. The tissue processors were not ventilated, thus the vapors were able to permeate the air. One tissue processor was positioned next to an open window, but this was unsatisfactory for controlling solvent vapors.

Formaldehyde

Forty-four TWA formaldehyde air samples were collected from ten laboratories during the initial survey. The air concentrations ranged from non-detected to 0.7 ppm; however, the majority of the air samples (43 samples) were non-detectable. The air samples were collected in proximity to the tissue processor, while changing the processor solutions, during grossing and tissue dumping. High formaldehyde air sample results were anticipated based on the investigators observation of employees work practices and the symptoms of irritation (eye, nose and/or throat) experienced by the employee and/or the investigator. Since only one air sample detected formaldehyde using a relatively new method (chromosorb-tube) which has a 0.5 ppm detection limit, it was decided to re-evaluatetwo of the work environments using a more sensitive sampling method. Five air samples were collected from two labs and the air concentration ranged from non-detected to 1.9 ppm which is above the NIOSH recommended criterion.

Several problems were observed to be associated with employee exposure to formalin and these are as follows: First, the majority of the laboratories keep the unventilated tissue processor in the general work area thus the chemical vapors are able to permeate the air. Second, most of the tissue dumping is not done under a laboratory exhaust hood or some other local exhaust ventilation. Third, only one lab provided the technician with a respirator during tissue dumping, however, the technician received no respirator training. The respirator was improperly worn and not cleaned or stored properly. Additionally, NIOSH recently discovered that phenol, xylene, toluene and alcohol produce major negative interferences with the NIOSH Analytical Method Number 125, thus, the formaldehyde air exposures should be considered minimal. A new analytical method is currently being tested to determine whether these chemicals still produce formaldehyde interference.

VI. CONCLUSIONS

Although workroom air levels of xylene and toluene were generally low based on time-weighted averages, there were instances where xylene air concentrations were high for brief periods causing temporary discomfort to the staff or investigator even though the NIOSH recommended criterion may not have been exceeded. Employee overexposure to formaldehyde and chloroform were measured at several facilities during the follow-up survey. However, based on recent NIOSH findings, the formaldehyde air results should be considered minimal exposures, due to the chemical interference during analysis. The investigators recommendations, provided in the following section, are based on observations of work practices which reflects good industrial hygiene practice in achieving a safe and healthful work environment.

It appears that there is a hazard associated with exposure to the fixatives and solvents used in current histopathology. The frequency of symptoms is certainly high, and there appears to be objective evidence of impairment, particularly among those with 20 years or more exposure.

VII. RECOMMENDATIONS

1. Preparations of dilute formalin solutions fixatives etc. should be in a laboratory exhaust hood.

2. Local exhaust ventilation should be used to control chemical vapors instead of general room exhaust ventilation.

3. Tissue processors should be enclosed and ventilated to the outdoors, or the tissue processors should be isolated from the general work area.

4. All laboratory hoods should be periodically checked to determine whether average linear face velocity of 150 feet per minute are maintained.

5. Portable hoods should have charcoal filters replaced according to manufacturers recommendations.

6. Disposal of tissue samples should be done under a laboratory exhaust hood or employee should be provided proper respiratory protection. If respirators are to be used by employees', then the company should institute a formal respirator program in accordance with the Occupational Safety and Health Act (OSHA) requirements outlined in 29 CFR Part 1910.134. The respirator program should include the followng: proper respirator selection, training and education of the user, fit testing, maintenance of equipment, proper and adequate storage, periodic inspection, surveillance of work area conditions, periodic inspection of program to determine the continued effectiveness and medical examination of workers using the respirators.

8. Coverslipping of slides should be done under the lab hood, and the fan should be turned on.

9. There should be periodic air monitoring of the laboratory environment to ascertain whether the ventilation controls are working properly.

10. Eating and drinking in the laboratory should be discouraged.

VIII. REFERENCES

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X. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standard Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. California Society for Histotechnology - Los Angeles Chapter.
2. Particpating laboratories.
3. U.S. Department of Labor/OSHA - Region IX.
4. CAL-OSHA
5. NIOSH - Region IX
6. Medical contractor.

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

TABLE 1

PERCENT REPORTING
RESPIRATORY SYMPTOMS

HETA 81-422

	SMOKERS N=40		NON-SMOKERS N=32		LA CONTROLS N=56
Any Resp. Complaint	62	(40)	40.6	(13)	54
Bronchitis	25	(12)	19	(2.2)	25
Colds	52.5	(15.6)	62.5	(14.3)	66
Cough	19	(17.7)	17	(3.5)	12
SOB	26	(7.5)	16	(3.3)	18
Wheezing	23.8	(20.8)	18.8	(7.4)	18
Cough & Phlegm	10	(10)	10	(2)	20

(Data in parentheses are from Deetels et al. UCLA Population Studies of COPD. Chest 78:250, 1980).

TABLE 2

HETA 81-422

PERCENT REPORTING

EMPLOYMENT RELATED SYMPTOMS

	SMOKERS N=40	NON-SMOKERS N=32	LA CONTROLS N=56
All Physical Symptoms	78.6	77.4	39
Tightness	36	28	5
Palpitations	33	22	9
Burning in chest	36	28	5
SOB	28.6	31.5	0
Cough	31	25	9
Dry Mouth	43	43.5	20
Throat Irritation	40	41	12
Eye Irritation	57	59	20
Smell Reduced	26	28	5

TABLE 3

HETA 81-422

PERCENT REPORTING

EMPLOYMENT RELATED NEUROBEHAVIORAL SYMPTOMS

	SMOKERS N=40	NON-SMOKERS N=32	WISC. N=92	MICH. N=166	LA N=56
ALL	83	91			
HEADACHE	59.5	56	8.7	39	37
NAUSEA	38	25			2
DIZZINESS	47.6	37.5	5.4	26	5
LIGHTHEADEDNESS	53	37.5	1.1	27	5
LOSS OF BALANCE	40	31	1.1	18	7
FATIGUE	71	62.5	11.9	54	43
INSOMNIA	31	31	2.2	18	14
IRRITABILITY	50	43.8	2.2	25	21
MEMORY LOSS	35	31	2.2	6	12

TABLE 4

HETA 81-422

FREQUENCY ONSET OF ALL SYMPTOMS

	All Tech.		LA Controls (percent)
Physical Symptom with onset during work	71%	Morning 49% Afternoon 49%	37
Physical Symptom with onset after work	43%		32
Behavioral Symptom with onset during work	71%	Morning 45% Afternoon 58%	43
Behavioral Symptom with onset after work	59%		57
Persistence after work	50%		37
Physical	27%		28
Behavioral	31%		23
Sought Medical Attention for Symptoms	27%		25

TABLE 5

HETA 81-422

PERCENT REPORTING
SKIN MANIFESTATIONS ASSOCIATED WITH WORK

	Tech. N=76	Controls N=56
ITCHING	29	18
DRY	52	20
BURNING	34	0
CRACKING AND BLEEDING	40	9
TIGHTNESS	37	5
PEELING AND SCALING	44	23
THICKENING	28	2
REDNESS	30	5
NAIL CHANGES	25	0

TABLE 6

HETA 81-422

AGE DIFFERENCES IN SYMPTOMS (percent)

	Younger (32 y)		Older (52 y)	
Physical Symptoms	Technicians	Controls	Technicians	Controls
Tightness	30	3	37.5	8
Palpitations	25	10	37.5	8
Burning chest pain	25	3	41	8
SOB Working	32.5	0	28	0
Cough	30	6.4	28	12
Dry Mouth	42.5	16	47	24
Throat	42.5	19	41	4
Eye	52.5	22.6	65.6	16
Smell	27.5	0	28	12
Behavioral Symptoms				
Headache	65	37.8	50	32
Nausea	30	22.6	34	0
Fatigue	25	45	53	40
Dizziness	35	3.2	56	8
Insomnia	28	6.8	38	20
Lightheadedness	45	6.5	53	4
Irritability	47	22.6	47	16
Loss of Balance	25	0	53	16
Memory Loss	33	3.2	34	24
Persistence After Work	55	38.7	63	32

TABLE 7

HETA 81-422

COMPARISON OF QUESTIONNAIRE RESPONSES AND DERMATOLOGICAL EXAMINATION FOR 19 WOMEN WHO ARE HISTOLOGY TECHNICIANS

	Questionnaire N=19 %	Dermatological Exams N=19 %
ITCHING	37	58
DRYNESS	74	74
BURNING	26	58
CRACKING AND BLEEDING	37	74
TIGHTNESS	42	53
DARKENING	10.5	47
LIGHTENING	21	42
PEELING AND SCALING	53	63
THICKENING	26	68
THINNING	5.3	42
BLISTER	21	42
PAIN	21	42
REDNESS	31.6	47.4
BOILS	0	42
NAIL	31.6	47.4

TABLE 8

HETA 81-422

FREQUENCY OF ALL SYMPTOMS AT WORK

SYMPTOMS	WOMEN	MEN	TOTAL
0-5	16	10	26
6-10	17	3	20
11-15	11	2	13
16-20	8	3	11
21-25	11		11
26-30	9		9
31-35	3		3
36-40	1		1

Physical Symptoms	73	6 or more	25
Neurobehavioral Symptoms	80	11 or more	18
Dermatological Symptoms	75	9 or more	6

TABLE 9

HETA 81-422

Pulmonary Function Testing

Four of 25 had reduced FEV_1 below 75% of predicted (66, 23, 73, 67).

Seven of 25 persons tested had at 19% or greater improvement in forced expiratory flow 25-75% after bronchodilators (25, 45, 19, 22, 21, 30, 22)

In 32 non-smokers mean peak flow, done at the work site was 96.2% of predicted.

In 44 smokers mean peak flow, done at the work site was 94.9% of predicted.

Neurobehavioral Testing

	Histotechs Los Angeles N=24	Wisconsin farm women	Michigan strat. sample
Block Design	30.4	26.9	24.8
Digital Symbol	54.3	57.0	56.6
Embedded Figures	31.6	32.8	33.9
Age	37.8	30-49	30-49
Educational Level*	4.3	3.19	2.94

*3 = high school, 4 = college, 5 = masters degree

TABLE 10

HETA 81-422

Work Related Physical Symptoms for Three Levels of Formaldehyde Exposure and Two Levels of Xylene-Toluene Exposure at the Highest Formaldehyde Level in Women (percentage)

Symptom	Formaldehyde Exposure				
	0 hours/day N=7	1-3 hours/day N=22	4 or more hours/day N=47	low xylene N=27	high xylene N=20
Any	57	68	87	89	85
Chest Tightness	14	27	40	26	60
Palpitations	0	27	38	26	55
Chest pain-burning	14	23	40	37	45
SOB rest	0	4.5	21	19	25
SOB work	14	27	38	37	40
Dry Cough	14	23	34	22	50
Cough of mucus	14	0	19	7	35
Cough of blood	0	0	8.5	4	15
Dryness of mouth	43	50	47	41	55
Throat Irritation	14	36	49	37	65
Eye Irritation	28	59	66	63	70
Decreased smell	14	32	32	22	45
m Age	39.3	39.5	41.4		
Peak Flow rate l/min	500	451	441		

HETA 81-422

Work Related Behavioral Symptoms for Three Levels of Formaldehyde Exposure and Two Levels of Xylene-Toluene Exposure at the highest formaldehyde level in Women (percentages)

	Formaldehyde Exposure				
Symptom	0 hours/day	1-3 hours/day	4 or more hours/day		
	N=7	N=22	all N=47	low xylene N=27	high xylene N=20
Any	86	86	87	81	95
Headache	57	59	62	48	80
Nausea	14	18	42	30	60
Dizziness	14	27	57	52	65
Lightheadness	28	41	57	48	70
Exhilaration	14	14	8	10	7
Loss of balance	57	32	38	37	40
Loss of consciousness	0	4	2	4	0
Fatigue	57	64	74	78	70
Somnolence	14	32	32	26	40
Insomnia-cannot fall asleep	0	23	32	26	40
Insomnia-wake frequently	0	27	40	33	50
Insomnia-sleep few hours	0	18	23	19	30
Irritability	28	36	55	44	70
Lack of concentration	14	9	42	44	40
Recent memory loss	14	27	40	56	20
Long term memory loss	14	14	19	22	15

Table 11 (Con't)

Symptom	0 hours/day	1-3 hours/day	4 or more hours/day		
	N=7	N=22	all N=47	low xylene N=27	high xylene N=20
Instability of mood	0	9	38	33	45
Libido changed	0	18	17	11	25
Alcohol tol.	14	14	30	33	25
Indigestion	14	9	38	22	60
Loss of appetite	0	4	30	22	40

TABLE 12

HETA 81-422

Physical Symptoms - Work Related for Histology Technicians and Controls (Percentages of group with positive responses)

	Percentage			
	All HT's N=76	All Cont's N=56	Matched HT's N=46	Matched Cont's N=46
S(1.	79	39	78	41
(2) Chest Tightness	34	5	33	4.3
(3) Palpitations	32	9	30	11
(4) Chest pain -burning	33	5	35	4.3
(5) SOB rest	14	0	17	0
(6) SOB work	33	0	39	0
(7) Dry Cough	29	9	26	6.5
(8) Cough w/mucus	18	9	26	8.7
(9) Cough w/blood	5.3	1.8	6.5	2.2
(10) Dryness mouth,nose, throat	47	20	48	17
(11) Throat irritation	42	12	39	13
(12) Eye irritation	60	20	63	20
(13) Decreased sense of smell	30	5	35	4.3

TABLE 13

HETA 81-422

Behavioral Symptoms - Work Related for Histology Technicians and Controls (percentages of group with positive responses)

	Percentage			
	All HT's N=76	All Cont's N=56	Matched HT's N=46	Matched Cont's N=46
S(14) Any	87	61	89	56
(15) Headache	60	37	61	35
(16) Nausea	33	2	37	2.2
(17) Dizziness	45	5	48	4.3
(18) Light-headness	50	5	54	4.3
(19) Exhila-ration	10	2	11	0
(20) Loss ot balance	38	7	39	4.3
(21) Loss of consciousness	2.6	0	4.3	0
(22) Fatigue	70	43	72	39
(23) Somnolence	30	5	30	4.3
(24) Insomnia- can't fall asleep	26	1.1	28	6.5
(25) Insomnia- wake frequently	33	14	33	11
(26) Insomnia- sleep only a few hours	20	5	33	2.2
(27) Irrita-bility	47	21	46	20
(28) Lack of concentration	30	14	33	11
(29) Recent memory loss	34	12	35	13
(30) Long term memory loss	17	12	20	13

TABLE 14

HETA 81-422

Dermatological Symptoms - Work Related for Histology Technicians and Controls (Percentages of group with positive responses)

[Hands + other sites]	All HT's N=76	All Cont's N=56	Matched HT's N=46	Matched Cont's N=46
S(62) Itching	47	18	46	17
(63) Dryness	78	20	83	20
(64) Burning	45	0	46	0
(65) Crack & bleed.	49	9	50	11
(66) Tightness	50	5.4	50	6.5
(67) Darkening	9.2	9	8.7	8.7
(68) Light areas	20	5.4	17	4.3
(69) Peeling/ scaling	56	23	56	22
(70) Thicken- ing	32	1.8	30	2.2
(71) Thinning	5.3	3.6	4.3	2.2
(72) Blister- ing	20	3.6	15	2.2
(73) Pain	18	0	15	0
(74) Redness	39	3.6	37	6.5
(75) Hair loss	6.6	9	8.7	6.5
(76) Boils	3.9	7	2.2	4.3
(77) nail changes	34	0	30	0

Table 13 (Con't)

	All HT's N=76	All Cont's N=56	Matched HT N=46
(32) Libido	16	12	15
(33) Alcohol tol	24	21	26
(34) Indiges- tion	28	8.9	26
(35) Loss of appetite	20	0	22

TABLE 15

May 18, 1982

PERSONAL AIR SAMPLES COLLECTED

FOR XYLENE AND TOLUENE

LABORATORY #1

Histology Laboratory

LOS ANGELES, CALIFORNIA

HETA 81-422

Description/Location	Sample Period	Concentration (ppm)[1] Xylene	Toluene
Preparation of special stains and other solutions	0659-1452	8.9	8.9
Coverslippping	0701-1450	12.6	12.6
Staining	0704-1452	10.4	10.5

---

1) ppm - Parts of a vapor or gas per million parts of contaminated air.

2) TWA - Time-weighted average concentration for a normal 8-hour day, 40-hour work week.

NIOSH Criteria

1) Xylene (TWA)[2] - 100 ppm

3) Toluene (TWA) - 100 ppm

TABLE 16

ENVIRONMENTAL AIR SAMPLES COLLECTED

FOR XYLENE AND CHLOROFORM

Histology Laboratory #2

LOS ANGELES, CALIFORNIA

MAY/SEPTEMBER, 1982

HETA 81-422

Date	Type Sample	Location/Description	Sample Period	Concentration(ppm)[1] Xylene	Chloroform
5/18	P[2]	Embedding, cutting and staining	0730-1510	3.3	4.1
5/18	P	Spec stains, re-embedding	0730-1505	1.5	3.0
5/18	P	Embedding, cutting and staining	0732-1420	3.3	4.5
5/18	P	Methacrylate embedding	0735-1420	1.4	0.4
5/18	P	Special stains	0740-1505	2.6	3.6
9/22	A[3]	Middle of office on work table	0724-0824	--	5.9(c)[4]
9/22	A	Next to tissue processor	0727-0827	--	7.1(c)
9/22	A	Middle of office on work table	0827-0927	--	6.2(c)
9/22	A	Next to sink	0927-1027	--	4.8(c)
9/22	A	Middle of office on work table	1025-1125	--	4.6(c)
9/22	A	Middle of office on work table	1125-1225	--	4.4(c)
9/22	A	Next to balance	1226-1326	--	2.7(c)
9/22	A	Next to balance	1326-1426	--	6.0(c)

1) ppm - Parts of a vapor or gas per million parts of contaminated air

2) P - Personal air sample

3) A - Area air sample

4) C - Ceiling sample collected for a specified duration. This is the maximum air concentration to which an employee may be exposed

5) TWA - Time-weighted average concentration for a normal 8-hour workday and 40-hour workweek.

NIOSH Criteria

1) Xylene (TWA)[4] - 100 ppm

2) Xylene (C-10 min.) - 200 ppm

3) Chloroform (C-60 min.) - 2 ppm

TABLE 17

PERSONNEL AIR SAMPLES

COLLECTED FOR XYLENE

Histology Laboratory #3

LOS ANGELES, CALIFORNIA

MAY 18, 1982

HETA 81-422

Location/Description	Sample Period	Xylene Concentration(ppm)[1]
Microtoming	0620-1330	0.2
Microtoming	0625-1400	0.9
Microtoming, Embedding	0630-1315	0.4
Supervisor - Microtoming, special staining	0640-1430	0.2
Microtoming	0830-1430	N.D.[2]
Staining	0840-1455	0.7
Microtoming	0840-1455	N.D.

---

1) ppm - parts of a vapor or gas per million parts of contaminated air.

2) ND - none detected.

3) TWA - time-weight average concentration for a normal 8-hour workday and 40-hour workweek.

NIOSH Criteria:

1) Xylene (TWA)[3] - 100 ppm

TABLE 18

PERSONNEL AIR SAMPLES
COLLECTED FOR XYLENE

Laboratory #4
Anatomical Pathology Lab.
LOS ANGELES, CALIFORNIA
MAY 19, 1982
HETA 81-422

Location/Description	Sample Period	Xylene Concentration(ppm)[1]
Embedding	0732-1230	2.3
Embedding	0734-1315	1.5
Embedding, clean up of equipment using Xylene	0735-1340	7.4
Microtoming	0739-1340	17.5
Supervisor	0740-1430	4.3
Microtoming	0742-1405	3.1
Purging and cleaning tissue Processor	0842-1432	2.2
Surgical cutting and staining	0845-1215	4.4
Room A-127 special stains	0850-1330	N.D[2]
Room A-127 special stains	0850-1330	N.D

1) ppm - parts of a vapor or gas per million parts of contaminated air.
2) N.D.- None detected
3) TWA - Time-weighted average concentration for a normal 8-hour day, 40 hour work week.

NIOSH Criteria:

1) Xylene (TWA)[3] - 100 ppm

TABLE 19

PERSONNEL AIR SAMPLES
COLLECTED FOR XYLENE,
Histology Laboratory #5
LOS ANGELES, CALIFORNIA
MAY/JUNE, 1982
HETA 81-422

Date	Location/Description	Sample Period	Xylene Concentration (ppm)[1]
5/15	Lab-Room 2S-30 - Embedding, cleaning machine with Xylene, Replenishing Processor with solutions, staining	0732-1201	11.6
5/24	Embedding, coverslipping, Replacing two Processor solvents, cleaning, embedding machine	0643-1420	9.0
6/4	Embedding, cleaning and labeling slides	0611-1335	3.2
6/4	Special staining	0803-1625	7.7

---

1) ppm - Parts of a vapor or gas or per million parts of contaminated air

2) TWA - Time-weighted average concentration for a normal 8-hour day, 40 hour workweek.

3) C - Ceiling sample collected for a specified duration. This is the maximum air concentration to which an employee may be exposed.

NIOSH Criteria:

1) Xylene (TWA)[2] - 100 ppm

TABLE 20

PERSONNEL AIR SAMPLES

COLLECTED FOR XYLENE

Histology Laboratory #6

Los Angeles, California

May 19, 1982

HETA 81-422

Description/Location	Sample Period	Xylene Concentration(ppm)[1]
Embedding/Staining	0615-1445	1.9
Embedding/Staining	0645-1435	1.2
Microtoming	0705-1455	0.5
Microtoming	0710-1505	0.7
Microtoming	0735-1500	0.2
Grossing	0740-1505	0.6
Surgical Pathology Tech.	1040-1345	N.D.[2]

NIOSH Criteria:

1) Xylene (TWA)[3] - 100 ppm

1) ppm - Parts of a vapor or gas per million parts of contaminated air.

2) N.D.- None detected.

3) TWA - Time-weighted average concentration for a normal 8-hour workday and 40-hour workweek.

4) C - Ceiling sample collected for a specified duration. This is the maximum air concentration to which an employee may be exposed.

TABLE 21

ENVIRONMENTAL AIR SAMPLES
COLLECTED FOR FORMALDEHYDE
Histology Laboratory #6
LOS ANGELES, CALIFORNIA
SEPTEMBER 23, 1982
HETA-81-422

Description/Location	Type	Sample Period	Formaldehyde Concentration(ppm)[1]
During tissue dumping	P[2]	1155-1255	1.9
Pathologist cutting area	A[3]	1205-1305	0.5

1) ppm - parts of a vapor or gas per million parts of contaminated air.

2) P - Personal air sample.

3) A - Area air sample

NIOSH Criteria

1) Formaldehyde - Lowest feasible limit

TABLE 22

ENVIRONMENTAL AIR SAMPLES

COLLECTED FOR XYLENE

Histology Laboratory #7

LOS ANGELES, CALIFORNIA

MAY/SEPTEMBER 1982

HETA 81-422

Date	Type Sample	Location/Description	Sample Period	Xylene Concentration(ppm)[1]
5/21	P[2]	Micro-staining	0205-0830	5.9
5/21	P	Embedding and cutting	0210-0830	6.9
5/21	P	Embedding, cutting and staining	0210-0700	21.8
9/25	A[3]	On shelf above staining	0424-0434	14.3 (C)[4]
9/25	A	On shelf above staining	0436-0446	10.8 (C)
9/25	A	At cutting table	0446-0456	3.9 (C)
9/25	A	During cover slipping	0501-0511	63.9 (C)
9/25	A	During cover slipping	0519-0529	26.3 (C)
9/25	A	On shelf above staining	0458-0508	15.7 (C)
9/25	A	Recorders table	0517-0527	8.5 (C)
9/25	A	During cover slipping	0538-0548	12.9 (C)

1) ppm - parts of a vapor or gas per million parts of contaminated air.

2) P - Personal air sample

3) A - Area air sample

4) C - Ceiling sample collected for a specified duration. This is the maximum air concentration to which an employee may be exposed.

5) TWA - Time-weighted average concentration for a normal 8-hour workday and 40-hour workweek.

NIOSH Criteria:

1) Xylene (TWA)[5]-100 ppm

2) Xylene (C-10 min)-200 p

TABLE 23

PERSONNEL AIR SAMPLES

COLLECTED FOR XYLENE

Histology Laboratory #8

Los Angeles, California

MAY 20, 1982

HETA 81-422

Location/Description	Sample Period	Xylene Concentration(ppm)[1]
Staining	2246-0100	17.6
Staining	2142-0050	12.6

---

1) ppm - Parts of a vapor or gas per million parts of contaminated air.

2) TWA - Time-weighted average concentration for a normal 8-hour day, 40-hour work week.

3) C - Ceiling sample collected for a specified duration. This is the maximum air concentration to which an employee may be exposed.

NIOSH Criteria:

1) Xylene (TWA)[2] - 100 ppm
2) Xylene (C-10min)[3] - 200 ppm

TABLE 24

PERSONAL AIR SAMPLES COLLECTED

FOR XYLENE AND CHLOROFORM

Laboratory #9

HISTOLOGY LAB.

LOS ANGELES, CALIFORNIA

MAY THRU OCTOBER, 1982

HETA 81-422

Date	Description/Location	Sample Period	Concentration (ppm) [1] Xylene	Chloroform
5/21	Embedding, staining	0719-1527	9.5	6.9
5/21	Embedding, cutting, clean tissue processor, coverslipping.	0722-1459	7.2	5.2
5/21	Cleaning tissue processor, loading cassettes into processor, bookkeeping.	0726-1502	6.8	5.0
5/21	Cutting, cleaning processor, coverslipping cleaning and embedding.	0732-1556	6.7	4.8
6/8	Embedding, sorting of paraffin blocks, cutting and loading of cassettes	0730-1455	3.2	2.3
6/8	Rotating solutions on tissue processor, washing tissue containers.	0830-1459	2.8	2.0
9/28	Changing tissue processor solutions.	0932-1034	--	19.1(c)
9/28	Coverslipping	0848-0856	102(C)	--
10/6	Coverslippping	1124-1134	14.3(C)	--
10/6	Coverslipping	1144-1154	32.5(C)	--

1) ppm - Parts of a vapor or gas per million parts of contaminated air.
2) TWA - Time-weighted average concentration for a normal 8-hour day, 40-hour work week.
3) C - Ceiling sample collected for a specified duration. This is the maximum air concentration to which an employee may be exposed.

NIOSH Criteria: 1) Xylene (TWA)[2] - 100 ppm; 2) Xylene (C-10min)[3] - 200 ppm; 3) Toluene (TWA) - 100 and 4) Chloroform (C-60min) - 2 ppm.

TABLE 25

PERSONAL AIR SAMPLES

COLLECTED FOR FORMALDEHYDE

Laboratory #9

Histology Lab.

LOS ANGELES, CALIFORNIA

MAY/JUNE, 1982

HETA 81-422

Date	Location/Description	Sample Period	Formaldehyde Concentration(ppm)[1]
5/21	Disposing spent 10% formalin and replenishing containers	0738-1138	N.D.[2]
5/21	Cleaning tissue processors, embedding	1143- 1556	N.D.
6/14	Neuro-room - removing tissue from container and sealing sample jars with paraffin.	0849-1008	N.D.
6/8	Cutting and loading cassettes	0730-1131	0.7
6/8	Neuro-room - washing tissue containers, pouring out spent 10% formalin.	0835-1228	N.D.
6/8	Embedding, cutting, sorting paraffin blocks	1134-1455	N.D.
9/27	Neuro-room, removing tissue from containers and washing containers.	0916-1029	N.D.
9/28	Change solutions in tissue processor.	0938-1038	0.2
9/28	Loading tissue processor with cassettes.	0930-1030	0.8

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1) ppm - Parts of a vapor or gas per million parts of contaminated air.

2) N.D.- None detected

NIOSH Criteria:

1) Formaldehyde - Lowest feasible limit

TABLE 26

PERSONNEL AIR SAMPLES

COLLECTED FOR XYLENE

Laboratory #10

HISTOLOGY LAB.

LOS ANGELES, CALIFORNIA

MAY/JUNE/OCTOBER, 1982

HETA 81-422

Date	Location/Description	Sample Period	Xylene Concentration (ppm)[1]
5/20	Embedding, cutting and staining	0640-1448	2.2
5/20	Cutting	0730-1448	0.7
5/20	Frozen Sect. preparation, staining	0905-1426	1.0
5/20	Cutting, coverslipping, plastic staining and embedding	0931-1753	5.0
6/4	Coverslipping, plastic embedding and changing solutions in tissue processors and changing staining solutions	0933-1754	4.2
10/6	Coverslipping	1002-1006	30
10/6	Coverslipping	1036-1048	28

1) ppm - parts of a vapor or gas per million parts of contaminated air

2) TWA - time-weighted average concentration for a normal 8-hour workday and 40-hour workweek

3) C - ceiling sample collected for a specified duration. This is the maximum air concentration to which an employee may be exposed

NIOSH Criteria:

1) Xylene (TWA)[2] - 100 ppm

2) Xylene (C-10min)[3] - 200 ppm