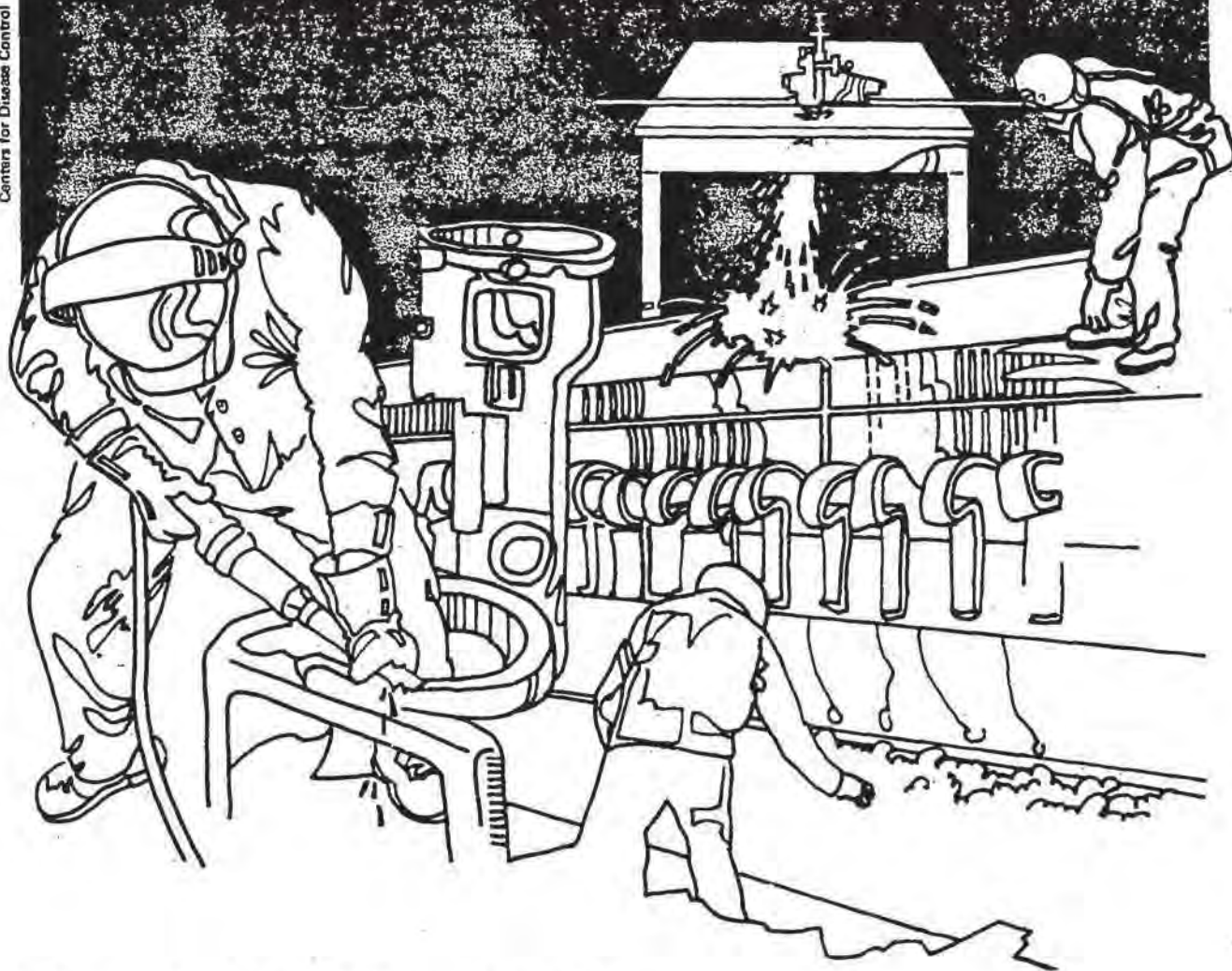


NIOOSH



Health Hazard Evaluation Report

HETA 83-047-1295
UNIVERSITY OF COLORADO
HEALTH SCIENCES CENTER
DENVER, COLORADO

PREFACE

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

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

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

I. SUMMARY

In December 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the University of Colorado Health Sciences Center, Denver, Colorado, to evaluate exposures to xylene, ethyl alcohol, and formaldehyde in the Histology and Cytology Departments.

On December 10 and 13-17, 1982, NIOSH investigators conducted an environmental and medical evaluation. A total of 120 breathing zone air samples were collected for measurement of exposure to xylene and ethyl alcohol on eight histologists and two cytologists. Values for xylene ranged from less than 0.01 mg/M³ to 58.0 mg/M³. The evaluation criterion for xylene is 435 mg/M³. Values for ethyl alcohol ranged from less than 0.01 mg/M³ to 250 mg/M³ which are also well within the evaluation criterion of 1900 mg/M³. Combined exposures to ethyl alcohol and xylene were still within acceptable limits.

Two different sampling techniques were used to collect thirteen sets of formaldehyde area samples between December 12 and December 17, 1982. Detectable levels of formaldehyde were measured on all but three samples. (Specific formaldehyde concentrations are not reported due to sampling difficulties and the presence of negative chemical interferences). There was an accidental syphoning of about 20 gallons of a 37% formaldehyde solution onto the floor in the chemical storage room on the first day following sampling. This spill was cleaned immediately and the area ventilated. Formaldehyde levels the next week were not noticeably different from those of the first day. The 1.2 mg/M³ level recommended by NIOSH in the criteria document is based on formaldehyde's irritant potential. Because of the carcinogenic potential of formaldehyde as outlined in the NIOSH Current Intelligence Bulletin No. 34, NIOSH currently recommends the lowest feasible exposure level.

All ten of the workers were interviewed for job history, illness related and/or unrelated to the job, use of medications, and smoking habits. Additionally, workers had blood drawn for complete blood counts and a Chem-Screen as there was no program for regular health assessment. Interviews revealed that 9 of the 10 had work-related headaches at least sometimes, and 5 of the 10 had, or had had, skin problems related to solvent exposure. Four of the 10 had at least a slight elevation of lactate dehydrogenase (LDH) which was weakly correlated with their time weighted average meta-xylene exposure ($r = 0.445$). Results of air flow measurements and urine metabolite analysis in relation to xylene exposures are part of a study by the NIOSH Division of Biomedical and Behavioral Sciences (DBBS), and will be included in a report of their study.

On the basis of the environmental data, NIOSH concluded that a health hazard to formaldehyde did exist at the time of this survey in the tissue processing room. Also there were medical problems due to mixed solvent exposure both by inhalation and dermal contact. However, air levels of both xylene and ethyl alcohol were within acceptable limits both individually and in combination. Recommendations on preventing and correcting exposures and monitoring worker health are included in this report.

KEYWORDS: SIC 8221 (Colleges, Universities, and Professional Schools), formaldehyde, histology and cytology laboratories, xylene, ethyl alcohol, headaches, dermatitis, liver function tests.

II. INTRODUCTION

In December 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the University of Colorado Health Sciences Center, Denver, Colorado, to evaluate xylene, ethyl alcohol, and formaldehyde exposures in the Histology and Cytology Departments.

On December 10 and 13-17, 1982, NIOSH conducted an environmental and medical evaluation. Environmental and blood sample results were sent to all participants of the study in February 1983.

Because the Division of Biomedical and Behavioral Sciences (DBBS) of NIOSH was interested in studying the levels of metabolites of xylene in the urine in relation to exposure levels, the health hazard evaluation was set up as a dual study. This report covers an overall assessment of the work place and possible health hazards. The results of the study being conducted by DBBS will be reported by them at some future date.

III. BACKGROUND

The Histology and Cytology Departments at the University of Colorado Health Sciences Center is composed of two histology rooms and one cytology room. These rooms are approximately 600 square feet each. There is a tissue processing room which is about 100 square feet. There is a small room for storage of formaldehyde, xylene, and ethyl alcohol. This room is approximately 80 square feet. There is also a small room the employees use for coffee and lunch breaks.

This investigation took place in the two histology rooms and one cytology room and the tissue processing room.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

A total of 120 ethyl alcohol and xylene air samples were collected on charcoal tubes using vacuum pumps operating at 50-200 cubic centimeters per minute and analyzed by NIOSH Method S-318.

Thirteen formaldehyde samples were collected on sorbent tubes containing Chromosorb 102 coated with N-benzylethanolamine using vacuum pumps operating at 50-200 cubic centimeters per minute and analyzed according to NIOSH P&CAM No. 354. These samples were collected for the entire work shift. Side-by-side samples were also collected for formaldehyde using impingers containing sodium bisulphite and analyzed by NIOSH P&CAM No. 125.

B. Medical

All ten (10) workers were included in the study. As the medical part of this study, workers were interviewed privately to obtain work histories, information on job related as well as non-job related illness, use of medications, and smoking history. Because it was found that workers had no routine medical monitoring, venous blood samples and fresh blood smears were obtained on all workers for complete blood counts (CBCs) and automated serum chemistries (Chem-Screen Profile).^{*} Age and sex adjusted normals from the laboratory running the tests were used for comparisons. Laboratory work was done by METPATH, 1 Malcolm Avenue, Teterboro, New Jersey. No attempt was made to obtain fasting blood, although the time since the last food was asked.

In addition to the interviews and blood work, urine samples, separated for each voiding, and breathing rates were obtained from each worker covering several days of the study. Breathing rates were obtained using a modified half-face respirator to measure air flow. The urine samples are being analyzed as part of the metabolic study. The details of breathing assessment, urine collection, and the analysis of results will be included in the DBBS report.

* Tests included in the Chem-Screen are: calcium, phosphate, BUN (blood urea nitrogen), creatinine, BUN/creatinine ratio, uric acid, glucose, total protein, albumen, globulin, albumen/globulin ratio, total bilirubin, direct bilirubin, SGOT (serum glutamate-oxaloacetic transaminase), SGPT (serum glutamic-pyruvic transaminase), alkaline phosphatase, LDH (lactate dehydrogenase), cholesterol, iron, magnesium, sodium, potassium, chloride, gamma-glutamyl transpeptidase, and triglycerides.

V. EVALUATION CRITERIA

A. Environmental

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.

Environmental criteria for substances evaluated in this investigation are shown below.

	Permissible Exposure Limits 8-Hour Time-Weighted Exposure Basis
Formaldehyde.....	* NIOSH, ACGIH 4.5 mg/M ³ OSHA
Ethyl Alcohol.....	1900 mg/M ³ ACGIH, OSHA
Xylene.....	435 mg/M ³ NIOSH, ACGIH, OSHA

mg/M³ = milligrams of substance per cubic meter of air.
* = suspect carcinogen--no safe exposure level given.

B. Medical

The complete blood count is useful in evaluating the presence of infection (elevated white blood counts [WBC] and shifts in the differential), allergic reactions (increased eosinophiles [EOS]), bone marrow depression (reduced numbers of red cells, white cells, and/or platelets) due to toxic inhibition or malignancy, anemias (iron deficiency in particular), or leukemias. Because of Denver's higher elevation than most population centers in this country, slight increases in the red cell indices probably represent an adaption to the lower oxygen concentration in the air.

As most workers were not fasting at the time their blood was drawn, no significance can be given to glucose levels or triglyceride levels except in a very general way--if normal they exclude gross abnormalities. The LDH (lactate dehydrogenase) level can be influenced by hemolysis of the blood specimen as red cells contain considerably more LDH than does the serum. Elevated levels of LDH are associated with a wide variety of tissue disorders as the enzyme is found in a wide variety of tissues.

Calcium, phosphate, magnesium, sodium, potassium, and chloride are measures of the body's electrolyte balance which is controlled by dietary intake, intestinal absorption and excretion through the kidneys. Hormone activity may be involved. Calcium, phosphate, and magnesium are also constituents of bone and so their levels can also reflect bone problems. Iron primarily reflects dietary intake and blood loss.

BUN, creatinine, and uric acid are used to measure the adequacy of kidney function in eliminating these metabolic by-products, although other metabolic factors may also be involved. Glucose and albumin levels can also be affected by improper kidney function.

The enzymes (SGOT, SGPT, alkaline phosphatase, gamma-glutamyl transpeptidase, and LDH) reflect liver activity. Glucose, albumin cholesterol, and triglycerides reflect more general metabolic activity in which dietary intake and liver activity are important factors as well as other organ systems. Bilirubin measures an excretory function of the liver along with the integrity of the biliary system.

As the antibodies are found in the globulin fraction of serum or plasma, globulin levels can reflect the functioning of the immune system.

The reference range for normal given for the blood results are age and sex specific and are applicable to the laboratory doing the tests. It should be remembered that the reference range is developed statistically and 5% of clinically normal results will fall slightly outside the reference range.

C. Toxicological

Formaldehyde¹ -- Formaldehyde is a colorless, flammable gas with a strong, pungent odor. It can form explosive mixtures with air and oxygen. Formaldehyde is usually manufactured by reacting methanol vapor and air over a catalyst. Formaldehyde usually will contain small amounts of methanol and formic acid. Formaldehyde is sold mainly as an aqueous (water-based) solution called formalin, which is 37-50% formaldehyde by weight with 10-15% methyl alcohol to inhibit polymerization.

The first signs or symptoms from exposure to formaldehyde at concentrations ranging from 0.1 to 5.0 parts per million (ppm) are burning of the eyes, tearing, and general irritation of the upper respiratory passages. Exposures of 10-20 ppm produces coughing, tightening in the chest, a sense of pressure in head, and palpitation of the heart. Exposures at 50-100 ppm and above can cause pulmonary edema, pneumonitis, or death.

Formaldehyde is often used to sterilize hemodialysis machines. There have been cases of pulmonary distress associated with this procedure. Dermatitis from formaldehyde exposure is a well recognized problem. After several days of exposure a worker may develop a sudden inflammatory reaction of the skin of the eyelids, face, neck, scrotum, and arms. Dermatitis may occur on fingers, back of hands, wrist, and forearms. Formaldehyde can also cause both dermal and respiratory allergic sensitization.

NIOSH recommends that formaldehyde be handled as a potential occupational carcinogen. These recommendations are based on a Chemical Industry Institute of Toxicology (CIIT) study in which laboratory rats and mice that were exposed to formaldehyde vapor developed nasal cancers. This is supported by a New York University study where rats exposed to a mixture of formaldehyde and hydrochloric acid vapors developed nasal cancers. Formaldehyde has also been shown to be a mutagen in several short-term laboratory studies.

Since formaldehyde has induced a rare form of nasal cancer in both rats and mice, NIOSH recommends that it be handled in the workplace as a possible occupational carcinogen. Exposure levels should be maintained as low as possible. The OSHA standard of 3 ppm was established based on the irritant effects of formaldehyde and not on the carcinogenic potential.

Xylene² -- Commercial xylene is usually a mixture of ortho, meta, and para xylene. The mixture is usually composed mostly of the meta-isomer. Xylene is a colorless liquid with an aromatic odor.

The current OSHA standard and the NIOSH recommended standard for xylene is 435 mg/M³ for a 40-hour work week.

Xylene can affect the body through inhalation, ingestion, or through skin absorption. Acute symptoms from exposure to xylene include irritation of the eyes, nose, and throat. Exposures above 435 mg/M³ will cause dizziness, drowsiness, and unconsciousness (symptoms of central nervous system depression). Prolonged high exposures may cause kidney and liver damage. Repeated skin exposures can cause defatting and dermatitis.

Ethyl Alcohol³ - Workers may receive exposure by either inhalation or ingestion. Ethyl alcohol is an irritant of the eyes and mucous membranes and causes central nervous system depression. In current medical and industrial practice the vapor of ethyl alcohol is considered to be almost devoid of systemic hazard from inhalation. The 1981 TLV and the OSHA standard of 1900 mg/M³ was set at a level to prevent irritation of eyes and respiratory system.

As both xylene and ethyl alcohol can cause central nervous system depression, as used in this evaluation they could have an additive effect. Combining the concentrations of xylene and ethyl alcohol did not pose a health hazard during this survey.

VI. RESULTS

A. Environmental

A total of 120 breathing zone air samples were collected for measurement of exposures to xylene and ethyl alcohol on eight histologists and two cytologists. Values ranged from less than 0.01 mg/M³ to 58.0 mg/M³ for xylene. The evaluation criterion for xylene is 435 mg/M³. Values for ethyl alcohol ranged from less than 0.01 mg/M³ to 250 mg/M³ which is also well within the evaluation criteria of 1900 mg/M³. Combined exposures to ethyl alcohol and xylene did not pose a health hazard. (Refer to Tables 1-11.)

Two different sampling techniques were used to collect thirteen sets of formaldehyde area samples between December 12 and December 17, 1982. Detectable levels of formaldehyde were measured on all but three samples. (Specific formaldehyde concentrations are not reported due to sampling difficulties and the presence of negative chemical interferences). There was an accidental syphoning of about 20 gallons of 37% formaldehyde onto the floor of the chemical storage room on Friday (the first day of sampling) following the air sampling for that day. Levels the next week did not show consistent deviations from the pre-spill levels.

The 1.2 mg/M³ NIOSH recommended level is based on formaldehyde's irritant properties and not on its carcinogenic potential. The carcinogenic potential of formaldehyde is outlined in the NIOSH Current Intelligence Bulletin No. 34.

B. Medical

By interview, all but one of the ten workers had headaches at work. These varied in frequency and duration but were more likely when running the tissue processing machine or doing a lot of coverslipping. There are occasions when most workers have headaches at the same time. Five of the 10 workers have had skin problems. One described it as being quite bad in the past, but no problem now as contact with xylene is avoided as much as possible. Another worker has a great deal of problem with skin exposure to xylene and can notice differences in the reaction to different batches of xylene.

On the Chem-Screen the only general abnormality was elevated LDHs. Of the 10 workers, 2 had slightly elevated LDHs and 2 had LDHs sufficiently elevated to suggest some follow-up by the individual worker. The mean LDH level for the 10 workers was 236.6 I.U./L (International Units per Liter) with a standard deviation of 49.7 I.U./L. Because age and sex specific reference levels were used, the lower limit of normal for individuals varied from 84.0 to 93.0 I.U./L and the upper limit of normal varied from 230 to 300 I.U./L. LDH levels correlated weakly with the time weighted average (TWA) exposure to meta-xylene ($r = 0.445$). Mean TWA for meta-xylene was 3.20 mg/M³ with a standard deviation of 2.39 mg/M³. In making this comparison the TWA for the one worker who worked only half time was reduced to half the measured level assuming there was no exposure away from work.

VII. DISCUSSION AND CONCLUSIONS

Based on medical interviews, there is a problem with headaches, probably caused by exposure to the total mix of solvents. In addition, solvent exposure caused dermal effects in half the workers at one time or another. Neither health problem is specific enough to implicate any one solvent, although one worker could relate a skin problem to xylene exposure. Air levels of xylene and ethanol were within acceptable limits, even when considered in combination, although this finding does not rule out the possibility of periodic exposures high enough to cause symptoms.

Based on medical findings of headache and skin problems there is a health hazard to mixed solvent exposures. A health hazard also exists from exposure to formaldehyde because of its allergic and carcinogenic potential.

VIII. RECOMMENDATIONS

1. Workers should be informed of the potential health effects from exposure to formaldehyde, xylene, and ethyl alcohol.
2. Ventilation should be installed that would prevent exposure to formaldehyde. A minimum of five air changes per hour in the tissue processing room would probably lower concentrations to non-detectable levels. Increased ventilation should also reduce the incidence of headaches.

3. Workers using xylene routinely should receive yearly medical screening with a health questionnaire, with follow-up examination and appropriate tests where necessary.

IX. REFERENCES

1. Current Intelligence Bulletin 34: Formaldehyde: Evidence of Carcinogenicity. NIOSH Publication No. 81-111, April 15, 1981.
2. National Institute for Occupational Safety and Health. NIOSH/OSHA occupational health guidelines for chemical hazards. Cincinnati, OH: National Institute for Occupational Safety and Health, 1981. (DHHS [NIOSH] publication no. 81-123).
3. Proctor, N.H. and Hughes, J.P. Chemical Hazards of the Workplace. J.B. Lippincott Company, Philadelphia, 1978, pp. 248-249.

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards 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. University of Colorado Health Sciences Center.
2. U.S. Department of Labor/OSHA - Region VIII.
3. NIOSH - Region VIII.
4. Colorado Department of Health.
5. State Designated Agency.

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

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl Alcohol

Histology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-16, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-1-A	Histologist	7:00 AM - 9:00 AM	*	3	*	11
12-13-82	1-1-B	Histologist	9:00 AM - 11:30 AM	*	2	*	10
12-13-82	1-1-C	Histologist	12:45 PM - 1:55 PM	1	4	*	15
12-14-82	1-11-A	Histologist	6:25 AM - 10:00 AM	*	3	*	7
12-14-82	1-11-B	Histologist	10:00 AM - 11:30 AM	*	*	*	*
12-14-82	1-11-C	Histologist	12:30 PM - 2:30 PM	1	6	.4	10
12-15-82	2-1-A	Histologist	6:20 AM - 9:35 AM	.3	2	*	3
12-15-82	2-1-B	Histologist	9:35 AM - 11:30 AM	.5	2	*	4
12-15-82	2-1-C	Histologist	12:15 PM - 2:30 PM	*	1	*	4
12-16-82	3-1-A	Histologist	6:30 AM - 12:00 N	.3	1	*	3
12-16-82	3-1-B	Histologist	1:00 PM - 2:30 PM	*	1	*	2
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 2

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-2-A	Histologist	7:15 AM - 9:00 AM	*	2	*	4
12-13-82	1-2-B	Histologist	9:00 AM - 11:30 AM	*	1	*	3
12-13-82	1-2-C	Histologist	12:45 PM - 2:30 PM	1	6	*	16
12-14-82	1-20-A	Histologist	6:15 AM - 9:10 AM	*	3	*	4
12-14-82	1-20-B	Histologist	9:10 AM - 11:30 AM	*	4	*	10
12-14-82	1-20-C	Histologist	12:30 PM - 3:30 PM	4	16	*	30
12-15-82	2-20-A	Histologist	6:20 AM - 9:30 AM	1	1	1	1
12-15-82	2-20-B	Histologist	9:30 AM - 11:30 AM	2	7	5	14
12-15-82	2-20-C	Histologist	12:15 PM - 2:00 PM	*	2	*	29
12-16-82	3-20-A	Histologist	6:20 AM - 12:00 N	.3	1	*	5
12-16-82	3-20-B	Histologist	1:00 PM - 3:30 PM	2	8	1	18
12-17-82	4-20-A	Histologist	6:12 AM - 11:30 AM	2	9	1	62
12-17-82	4-20-B	Histologist	12:30 PM - 2:30 PM	*	4	*	68
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 3

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-16, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-3-A	Histologist	7:15 AM - 9:00 AM	1	5	*	12
12-13-82	1-3-B	Histologist	9:00 AM - 11:30 AM	1	4	*	13
12-13-82	1-3-C	Histologist	12:15 PM - 3:20 PM	*	3	*	10
12-14-82	1-30-A	Histologist	6:55 AM - 9:15 AM	1	3	*	3
12-14-82	1-30-B	Histologist	9:15 AM - 11:30 AM	*	1	*	7
12-14-82	1-30-C	Histologist	12:30 PM - 3:30 PM	*	2	*	5
12-15-82	2-30-A	Histologist	7:05 AM - 9:40 AM	*	6	*	10
12-15-82	2-30-B	Histologist	9:40 AM - 11:30 AM	2	7	*	13
12-15-82	2-30-C	Histologist	12:15 PM - 3:30 PM	1	5	*	10
12-16-82	3-3-A	Histologist	6:55 AM - 12:00 N	.4	1	*	4
12-16-82	3-3-B	Histologist	1:00 PM - 3:30 PM	*	1	*	5
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 4

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-4-B	Histologist	9:00 AM - 11:00 AM	*	1	*	4
12-13-82	1-4-C	Histologist	11:25 AM - 2:30 PM	.3	2	*	5
12-13-82	1-4-D	Histologist	2:30 PM - 2:45 PM	*	*	*	*
12-14-82	1-40-A	Histologist	7:05 AM - 9:20 AM	*	*	*	2
12-14-82	1-40-B	Histologist	9:20 AM - 2:50 PM	*	1	*	6
12-14-82	1-40-C	Histologist	3:00 PM - 3:30 PM	*	*	*	*
12-15-82	2-40-A	Histologist	7:15 AM - 9:45 AM	*	3	*	15
12-15-82	2-40-B	Histologist	9:45 AM - 11:00 AM	*	*	*	*
12-15-82	2-40-C	Histologist	12:07 PM - 3:00 PM	*	2	*	12
12-16-82	3-4-A	Histologist	7:15 AM - 11:00 AM	*	1	*	4
12-16-82	3-4-B	Histologist	12:00 N - 3:30 PM	*	*	*	*
12-17-82	4-4-A	Histologist	7:15 AM - 11:30 AM	.2	*	*	*
12-17-82	4-4-B	Histologist	11:30 AM - 1:00 PM	*	5	*	16
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 5

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl Alcohol

Histology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-5-A	Histologist	7:30 AM - 9:00 AM	3	13	*	45
12-13-82	1-5-B	Histologist	9:00 AM - 11:30 AM	*	6	*	19
12-13-82	1-5-C	Histologist	12:45 PM - 2:30 PM	*	5	*	14
12-14-82	1-50-A	Histologist	7:20 AM - 9:40 AM	1	4	*	7
12-14-82	1-50-B	Histologist	9:40 AM - 11:30 AM	*	2	*	7
12-14-82	1-50-C	Histologist	12:00 N - 3:30 PM	2	6	*	7
12-15-82	2-50-A	Histologist	7:20 AM - 9:45 AM	1	6	*	21
12-15-82	2-50-B	Histologist	9:45 AM - 11:30 AM	2	8	*	10
12-15-82	2-50-C	Histologist	12:15 PM - 3:35 PM	*	3	*	1
12-16-82	3-5-A	Histologist	7:00 AM - 12:00 N	*	1	*	6
12-16-82	3-5-B	Histologist	1:00 PM - 3:30 PM	5	21	1	39
12-17-82	4-5-A	Histologist	7:20 AM - 11:30 AM	1	5	*	16
12-17-82	4-5-B	Histologist	12:35 PM - 2:30 PM	10	44	4	70
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 6

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-6-A	Chief Histologist	9:20 AM - 10:20 AM	*	*	*	3
12-13-82	1-6-B	Chief Histologist	10:20 AM - 11:00 PM	*	*	*	1
12-13-82	1-6-C	Chief Histologist	11:30 PM - 1:01 PM	*	1	*	4
12-14-82	1-60-A	Chief Histologist	9:05 AM - 11:30 PM	*	*	*	8
12-14-82	1-60-B	Chief Histologist	12:43 PM - 5:00 PM	*	*	*	2
12-15-82	2-60-A	Chief Histologist	9:25 AM - 11:45 PM	*	*	*	1
12-15-82	2-60-B	Chief Histologist	12:30 AM - 3:30 PM	*	*	*	4
12-17-82	4-6-A	Chief Histologist	10:00 PM - 11:30 PM	*	*	*	1
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 7

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 14-17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-14-82	1-100-A	Histologist	7:03 AM - 9:26 AM	1	6	*	22
12-14-82	1-100-B	Histologist	9:26 AM - 11:30 AM	2	7	*	44
12-14-82	1-100-C	Histologist	12:30 PM - 3:30 PM	1	5	*	15
12-15-82	X-1	Histologist	7:00 AM - 9:40 AM	1	2	*	1
12-15-82	X-2	Histologist	9:40 AM - 11:30 AM	*	3	*	7
12-15-82	X-3	Histologist	12:15 PM - 3:30 PM	1	4	*	8
12-16-82	X-4	Histologist	7:00 AM - 12:00 N	*	2	*	7
12-16-82	X-5	Histologist	1:00 PM - 3:30 PM	*	4	*	15
12-17-82	4-7-A	Histologist	7:05 AM - 11:30 AM	1	5	.3	19
12-17-82	4-7-B	Histologist	12:30 PM - 3:00 PM	1	4	*	16
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 8

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-8-A	Cytologist	7:30 AM - 9:00 AM	*	*	*	55
12-13-82	1-8-B	Cytologist	9:30 AM - 11:45 AM	.2	7	*	88
12-13-82	1-8-C	Cytologist	11:45 AM - 2:30 PM	*	3	*	55
12-14-82	1-80-A	Cytologist	7:35 AM - 9:45 AM	2	7	*	12
12-14-82	1-80-B	Cytologist	9:45 AM - 11:30 AM	*	*	*	*
12-14-82	1-80-C	Cytologist	11:30 AM - 2:30 PM	1	4	*	27
12-14-82	1-80-D	Cytologist	2:30 PM - 5:00 PM	*	2	*	20
12-15-82	2-80-A	Cytologist	7:10 AM - 9:50 AM	*	1	*	4
12-15-82	2-80-B	Cytologist	9:50 AM - 12:30 PM	2	7	*	39
12-15-82	2-80-C	Cytologist	1:10 PM - 3:35 PM	*	1	*	7
12-16-82	3-8-A	Cytologist	8:10 AM - 12:00 N	*	1	*	36
12-16-82	3-8-B	Cytologist	1:00 PM - 2:00 PM	.5	2	*	17
12-17-82	4-8-A	Cytologist	7:10 AM - 11:30 AM	.3	2	*	8
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 9

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³			
				Ortho	Meta	Para	Ethyl Alcohol
12-13-82	1-9-A	Histologist	8:30 AM - 11:20 AM	2	7	*	31
12-13-82	1-9-B	Histologist	11:20 AM - 1:55 PM	1	3	*	35
12-13-82	1-9-C	Histologist	1:55 PM - 5:10 PM	1	6	.3	22
12-14-82	1-90-A	Histologist	9:30 AM - 12:20 PM	1	2	*	22
12-14-82	1-90-B	Histologist	2:00 PM - 2:50 PM	*	*	*	3
12-14-82	1-90-C	Histologist	2:50 PM - 5:00 PM	*	1	*	16
12-15-82	2-90-A	Histologist	8:20 AM - 12:30 PM	5	2	*	12
12-15-82	2-90-B	Histologist	11:30 AM - 4:40 PM	*	1	*	8
12-16-82	3-9-A	Histologist	8:40 AM - 12:50 PM	.3	1	*	13
12-16-82	3-9-B	Histologist	1:15 PM - 4:45 PM	*	1	*	13
12-17-82	4-90-A	Histologist	8:06 AM - 12:00 N	.4	2	*	14
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 10

Breathing Zone Air Concentrations of
Ortho, Meta, Para Xylene and Ethyl AlcoholHistology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 13-17, 1982

Date	Sample Number	Job Classification	Sampling Time	Ortho	Meta	mg/M ³ Para	Ethyl Alcohol
12-13-82	1-10-A	Cytologist	11:10 AM - 12:35 PM	*	1	*	6
12-13-82	1-10-B	Cytologist	1:35 PM - 5:10 PM	.5	1	*	48
12-14-82	2-100-A	Cytologist	12:05 PM - 2:30 PM	3	8	*	19
12-17-82	4-10-A	Cytologist	11:20 AM - 11:30 AM	5	20	1	250
EVALUATION CRITERIA				435	435	435	1900
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01	.01
approx. mg/M ³ for 8 hr. sample =				0.1			

* = below laboratory limit of detection

TABLE 11

Breathing Zone and General Room Air Concentrations of
Ortho, Meta, Para Xylene in the Tissue Process Room

Histology Department
University of Colorado Health Sciences Center
Denver, Colorado

December 10, 15, 17, 1982

Date	Sample Number	Job Classification	Sampling Time	mg/M ³		
				Ortho	Meta	Para
12-10-82	CT-10	General Room	9:55 AM - 10:20 AM	16	75	*
12-10-82	CT-100	General Room	9:30 AM - 11:00 AM	15	67	4
12-10-82	CT-101	General Room	9:30 AM - 11:00 AM	9	37	3
12-10-82	CT-102	Histologist	9:30 AM - 10:50 AM	8	28	*
12-15-82	CT-300	Histologist	1:20 PM - 1:45 PM	3	15	*
12-15-82	CT-301	Histologist	1:20 PM - 1:45 PM	7	28	2
12-15-82	CT-302	Histologist	1:45 PM - 2:00 PM	10	40	*
12-17-82	CT-400	Histologist	9:40 AM - 11:15 AM	4	17	2
12-17-82	CT-401	Histologist	9:50 AM - 10:20 AM	15	65	5
12-17-82	CT-501	Area	9:40 AM - 11:15 AM	6	26	2
12-17-82	CT-502	Area	9:50 AM - 10:20 AM	8	35	3
12-17-82	CT-503	Area	10:20 AM - 10:40 AM	5	18	2
EVALUATION CRITERIA				435	435	435
LABORATORY LIMIT OF DETECTION: mg/sample				.01	.01	.01
approx. mg/M ³ for 8 hr. sample = 0.1						

* = below laboratory limit of detection