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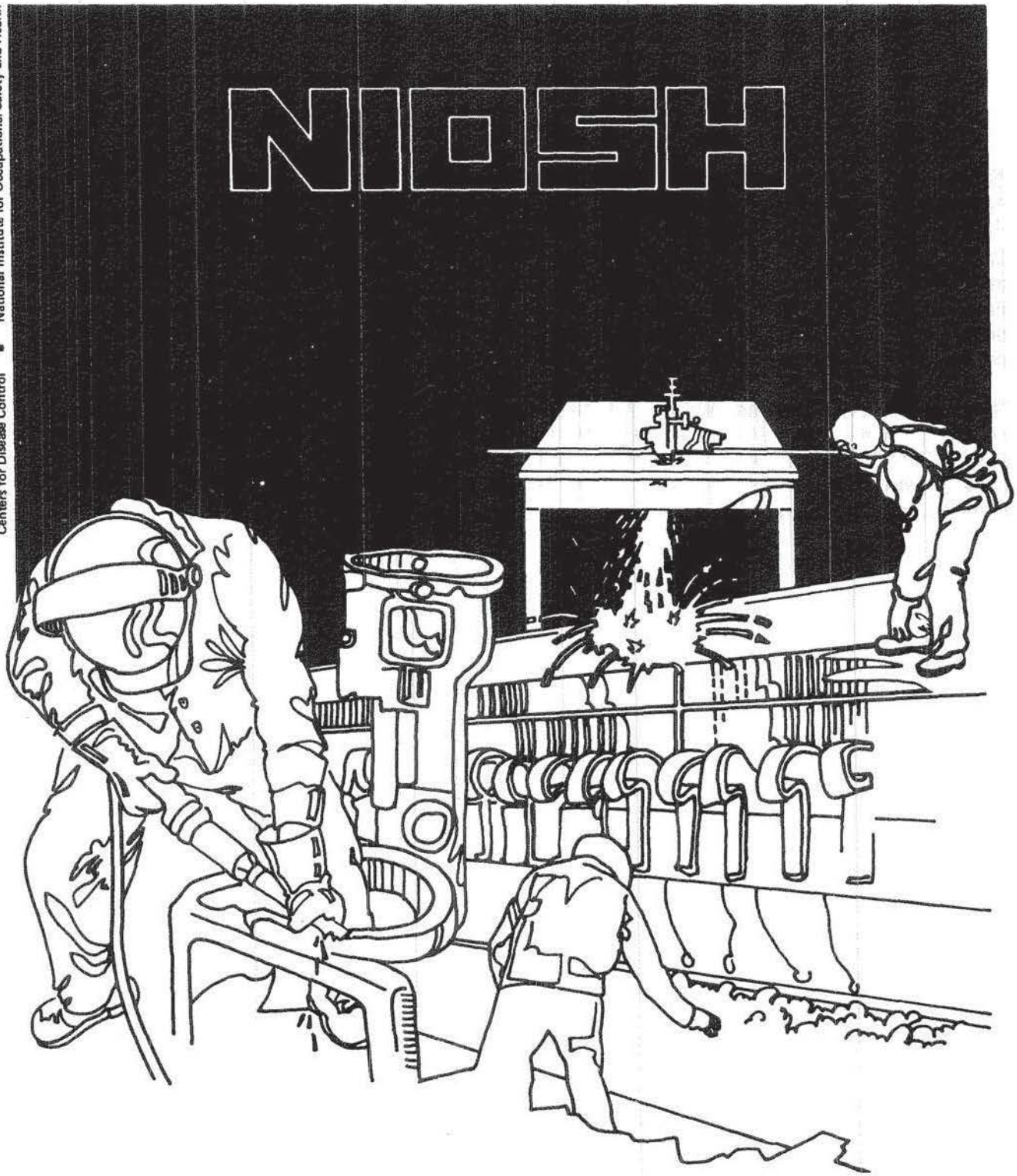
NIOSH



Health Hazard Evaluation Report

HETA 81-060-1367
LEATHER CRAFTSMAN
LYNBROOK, NEW YORK

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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LEATHER CRAFTSMAN
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I. SUMMARY

In October 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the management of Leather Craftsman for help in defining exposures to an industrial solvent, "Varnoline". Leather Craftsman manufactures custom photographic albums, including the gluing of customer-supplied photographs onto pages of the albums. Workers are exposed to the solvent while using a solvent-soaked cloth to wipe excess glue off of the pages. Concern was expressed that the solvent may contain benzene.

Analysis of the solvent indicated that it is a complex mixture of C7-C9 aliphatic hydrocarbons (90%), toluene and xylene (5% each). It does not contain benzene. Environmental sampling in October 1980 indicated that airborne concentrations of the solvent constitutents were substantially below the NIOSH recommended exposure limits for these substances.

While respiratory exposures are low, workers who use the solvent-soaked cloth may directly absorb solvent through their skin. To assess this possibility, NIOSH measured pre-shift and post-shift urinary concentrations of hippuric acid and methylhippuric acid as biological indicators of toluene and xylene, respectively. Post-shift urine concentrations of these metabolies among the album cleaners were higher than among unexposed populations, but lower than levels indicative of exposure to the maximum NIOSH exposure limits. Since toluene and xylene constituted a small proportion of the solvent, these findings suggest that workers exposure to the solvent may be noteworthy; however, actual levels can not be determined.

In a medical screening in June 1981, workers exposed to the solvent reported more acute "prenarcotic" symptoms than unexposed workers. The differences, however, were small. On physical examination, workers with direct skin contact with the solvent, and workers with contact with a water-based glue, had more dermatitis that unexposed workers.

Although airborne concentrations of the solvent are low, biological indicators of exposure to toluene and xylene indicate that workers who handle solvent-soaked cloths may be absorbing noteworthy levels of the solvent. These workers may be experiencing slightly more acute "prenarcotic" symptoms than unexposed workers, but the differences are small. Workers directly exposed to the solvent and to the water-based glue, demonstrated significant dermatitis in the areas of contact (hands and fingers). Recommendations are made in the body of the report.

KEYWORDS: SIC 2648 (Stationery, Tablets and Related Products); solvent, aliphatic hydrocarbons, octanes, toluene, xylene, prenarcotic symptoms, dermatitis.

II. Introduction

In October 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the management of Leather Craftsman, 315 Hendrickson Place, Lynbrook, New York, for help in defining exposures to an industrial solvent, "Varnoline". This solvent has been used for the past 20 years to remove excess glue from photographs being mounted in albums. Plant personnel have always referred to the solvent as "benzene". The employees, having learned of the potential carcinogenic properties of benzene, refused to work with the solvent. The material safety data sheet supplied by the distributors of Varnoline states that it was composed of petroleum naphtha. The management of Leather Craftsman requested NIOSH assistance in resolving this issue.

NIOSH conducted an environmental survey on October 20, 1980. In the survey, airborne levels of the solvent proved to be quite low; however, one could not rule out the potential for exposure via direct skin contact. An interim report was completed in April 1981. NIOSH returned on June 29, 1981, to conduct a medical screening of employees at the facility.

III. Background

Leather Craftsman manufacturers custom photographic albums. Each album has leather covers with heavy paper pages. Customer-supplied photographs are individually mounted on the pages with a water-based glue. Subsequently, "cleaners" use a cloth saturated with the Varnoline solvent to clean excess glue off of the completed pages.

The cleaning operations are performed in a 75'X 110' workroom. Various other operations such as leather cutting and embossing, mounting, glueing and assembling the albums also are performed in the workroom. The main cleaning area, in which approximately 10 workers are employed, is near the front-center of the room. In addition, 5 employees work in the rear of the building, cleaning the more elaborate photo albums. The solvent is kept in individual, plunger top safety containers. The cleaners saturate a cloth with the solvent and then rub the photographs with the cloth to remove any excess glue. The cleaners are responsible for quality control of the albums and the completeness of the removal of the glue or blemishes.

There are about 15 cleaners in a total work-force of 60 employees. Other major job categories include leather workers, sprayers (who spray a solvent-based lacquer on the album covers), mounters (who glue the photographs on the pages), and office workers. The office personnel work in a separate room at the front of the building. Ventilation for the office area is separate from the production areas of the building. The office workers spend very little time in the production areas.

The building is equipped with a heating/air handling system. There are five windows on the east wall of the building and several garage doors can be opened to provide additional general ventilation.

IV. Evaluation Design and Methods

A. Environmental

An industrial hygiene survey was performed on October 20, 1980. Refusing to use "Varnoline", the employees had been using substitute solvents and water to clean photographs for several weeks. After the purpose of the survey had been explained to the cleaners, they agreed to use Varnoline for one day so that exposure to air-borne concentrations of the solvent could be evaluated. Use of the solvent began in the morning. After the lunch break, samples were collected in the employee's breathing zones. Air pumps operating at 1.5 liters per minute were used to draw air through glass tubes containing activated charcoal. Solvent vapors passing through the tubes were absorbed onto the charcoal. These samples were analyzed using NIOSH method P & CAM 127 desorption with carbon disulfide followed by gas chromatography. A bulk sample of Varnoline also was collected and analyzed.

B. Medical

The initial environmental sampling results indicated that the cleaning solvent contained no "benzene" and that the airborne concentrations of the solvent components were fairly low. Thus, most of the employees resumed using the solvent. Subsequently, concern was expressed that the solvent may still represent a health hazard. While employees do not have significant respiratory exposure, the workers who clean the albums with solvent-soaked cloth could absorb the solvent through their skin.

Skin absorption cannot be measured environmentally, but can be estimated by measuring levels of the solvents in the body. It is difficult to measure solvent levels in blood; however, many solvents are converted to specific chemical metabolites which are then excreted in the urine. For several solvents, the relationship between environmental exposure and subsequent excretion of specific metabolites is well defined[1]. Toluene and xylene are metabolized to hippuric acid and methyl-hippuric acid, respectively. Thus, urinary levels of these acids can reflect environmental exposure to the two solvents.

Analysis of the bulk samples of the cleaning solvent indicated that it consists of 90% C7-9 aliphatic hydrocarbons and 5% each of toluene and xylene. There are no specific urinary metabolites of the aliphatic hydrocarbons; however, the urinary levels of hippuric acid and methyl-hippuric acid can still be used to indicate whether substantial absorption is occurring.

On Monday, June 29, 1981, NIOSH conducted a medical screening of the female (virtually all) employees of Leather Craftsman. Monday was selected in order to allow for the elimination of any hippuric acid from previous work exposures. Work exposures and health questionnaires were completed. A NIOSH medical officer examined the exposed skin of employees. Employees also gave specimens of urine before and after the work shift for analysis of creatinine and

hippuric acid. Hippuric acid was determined according to P&CAM 327 (NIOSH Manual of Analytical Methods Volume 6). The colorimetric method is not specific for hippuric acid. It also detects meta and para-methylhippuric acid-, the metabolite of meta-and para-xylene, respectively. Thus urinary levels would reflect exposure to both toluene and xylene.

The quantity measured was expressed as milligrams hippuric acid per milliliters of urine (mg/ml) and as grams hippuric acid per grams creatinine (g/gm cr) so as to correct for dilution of urine. The NIOSH laboratory reference interval is 0.2 to 0.6 mg/ml, but the levels may vary with diet.

V. Evaluation 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 conditions, 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 workers 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) ThresholdLimit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health 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 exposure.

Organic solvents usually consist of a mixture of short-chain aliphatic and aromatic hydrocarbons. To varying degrees, they all are capable of causing central nervous system depression, mucous membrane irritation, and drying and irritation of the skin.[1,2] Central nervous system depression results in symptoms such as tiredness, fatigue, lightheadedness, dizziness, and headache. Long-term exposures may cause subtle changes in mental performance, such as a decrease in short-term memory.

The environmental criteria for airborne concentrations of toluene, xylene, and octane (representative of the C7-C9 aliphatic hydrocarbons) are based on the NIOSH recommended standards and the Federal occupational health standards as promulgated by the Occupational Safety and Health Administration, U.S. Department of Labor. Table 1 lists the NIOSH recommended standards and OSHA standards and potential physiologic responses to toluene, xylene, and octane.

To assess the total level of solvent exposure, the urinary levels of hippuric and methylhippuric acid were measured. The level of these substances correlate well with exposure to toluene and xylene.[3,4] Approximately 80% of absorbed toluene is oxidized to benzoic acid, then conjugated with glycine and eliminated in the urine as hippuric acid. Likewise, xylene is excreted as methylhippuric acid.

While the laboratory reference interval for the test used in this evaluation is 0.2 to 0.6 mg/ml urine, NIOSH found in its review of the literature that normal, unexposed urinary levels of hippuric usually range from 0.7 to 1.0 mg/ml urine ,[5]. Pagnotto and Lieberman found that normal urinary concentrations of 0.4 to 1.4 mg/ml[6]. Furthermore, several investigators have reported a quantitative relationship between respiratory exposure to toluene and xylene and subsequent urinary excretion of hippuric/methylhippuric acid. ,[7,8] In general following exposure to airborne concentrations of toluene or xylene at the maximum exposure concentrations recommended by NIOSH (see Table 1), subjects in several experimental studies had subsequent urinary hippuric/methylhippuric acid concentrations of 3.0-3.5 mg/ml. Thus this level can be taken as a rough biological indication of exposure to the maximum level recommended by NIOSH.

It should be noted that hippuric acid is a normal urinary constituent derived from foods containing benzoate added as a preservative or occurring naturally. Thus levels can vary in an individual depending on diet. The best way to control variation in the testing method and for the effects of diet is to use a non-exposed control group. In this investigation, non-exposed office employees were used as a comparison group to assess normal urinary levels of hippuric acid.

Also, when hippuric acid is reported in mg/ml urine, it can vary depending on the dilution of the urine. Creatinine is another substance which is excreted in the urine. It is excreted at a fairly constant rate. Thus, comparing hippuric acid levels to creatinine (rather than volume of urine) acts to correct for dilution of urine. Our results will be reported in grams hippuric acid per grams of creatinine.

VI. Results and Discussion

A. Environmental

As mentioned above, analysis of the bulk sample of the Varnoline indicated that it was a complex mixture of aliphatic hydrocarbons, (C7 to C9) with octanes predominating. Toluene and xylene also were present in concentrations of about 5% each. No benzene was detected. This analysis corresponds to the information listed on the Material Safety Data Sheet in regard to boiling range and to the generally accepted composition of petroleum naphtha.

Table 2 shows the concentrations of airborne solvents (toluene, xylene and hydrocarbons, mostly octanes) to which the cleaners and mounters were exposed. The exposures to toluene and xylene were well within NIOSH and OSHA exposure criteria. The exposures to hydrocarbons among the cleaners ranged from 50 to 425 mg/M^3, averaging less than the NIOSH recommended standard.

B. Medical

On June 29, 1981, NIOSH conducted a medical screening of employees at the facility. Forty of the forty-nine female employees completed the questionnaire and had skin examinations. Seven male employees were not included in the study because none had regular contact with the cleaning solvent. Thirty-three of the 40 gave urine samples. Two persons gave preshift, but not postshift samples. Two samples could not be accurately analyzed because of high urine dilution. Thus data were complete for 29.

The workers were divided into five groups including 1) cleaners (n=8), 2) mounters (n=5), 3) sprayers (n=3), 4) office staff (n=5) and other workers (n=8). The exposures of the workers in group five were both varied and intermittent so that these workers did not fit into any of the other groups and a single sample of urine taken on any one day would not be representative of the average exposures. Therefore, the "other" group is not included in subsequent analysis.

Post-shift urine concentrations of hippuric/methylhippuric acid (subsequently referred to as hippuric acid) for the groups of workers are shown in Table 3. It appears that the cleaners had higher excretion of hippuric acid than any of the other groups of workers. The differences are not statistically significant; however, evaluation of statistical significance is not meaningful when comparing groups of such small size.

The average post-shift urine concentration of hippuric acid among the cleaners was higher than reported levels among non-exposed populations, but substantially below the levels cited as being equivalent to respiratory exposure to 375 mg/M^3 of toluene, which is the NIOSH recommended exposure limit. The urine concentrations cited in the reference reports, however, are based on exposure to pure toluene or xylene. In this instance, the workers were exposed to a solvent consisting of only 10% toluene and xylene and 90% aliphatic hydrocarbons. Since these results indicate that there was absorption of toluene and xylene even at low concentration present in the solvent, it is possible that absorption of the other solvent constituents was greater, but the levels cannot be determined.

The pre-shift to post-shift change in urine concentration of hippuric acid also was evaluated. The results are shown in Table 4. Consistent with the above results, the cleaners had a greater increase in urine hippuric acid concentration over the workshift than mounters or office workers. On the other hand, sprayers had the largest average increase in urinary excretion of hippuric acid over the workshift. These results may be due to the slightly lower initial urine levels among sprayers compared to the other groups, to exposure to toluene and xylene while spraying lacquer in the spray booth, or to higher ingestion of benzoate-containing foods at lunch. In any case, with only three workers in this group, interpretation of these findings is difficult and unreliable. Overall, one may conclude that the cleaners, and possibly the sprayers, may be exposed to solvents containing toluene and xylene.

Reported health symptoms were compared for the groups of workers. Based on a report by Husman[2], we divided reported symptoms into two categories - acute (during workshift) symptoms and general (chronic) symptoms. Acute symptoms included irritation symptoms (skin itching) and eight "prenarcotic" symptoms - nausea, vomiting, dizziness, drunken feeling, headache, shortness of breath, absentmindedness, and hearing tingling in ears. Chronic symptoms included 15 questions on fatigue, concentration difficulties, sleeping difficulties, and lability of mood. For each symptom, respondents were asked to indicate the frequency of occurence - never or almost never (scored 0), sometimes (1), or often (2).

Cleaners reported experiencing skin itching more frequently than office workers. Even with these small groups, the difference was near accepted significance ($P=0.07$ using a 3X2 exact test based on the hypergeometric function). It should be noted here that on physical examination of the employees, the cleaners uniformly had dry red fingers and some even had cracking and peeling of the skin on the

finger tips. The affected areas were generally localized to the fingers in which they held the solvent-soaked cloth. Four of the five mounters also had dry, scaling fingers. On the other hand, none of the office workers had dermatitis of the hands. Thus both the health questionnaire and the physical examination indicate that the cleaners (and probably the mounters) experience dermatitis due to direct skin exposure to the solvent (and water-based glue, respectively).

To compare the acute prenarcotic symptoms among the groups, we summed the reported symptom frequency scores for the eight symptoms. Thus each worker could score between 0 and 16 points based on the eight symptoms. The results shown in Figure 1. In general, the workers did not report having many symptoms; the symptom scores ranged only from 6 to 6. While there is substantial overlap in scores between the groups, it appears that the cleaners (and possibly sprayers) reported having more frequent acute prenarcotic symptoms compared to the mounters and office workers. These findings are consistent with the findings for urinary excretion of hippuric acid.

Chronic general symptoms also were compared by summing the symptom scores for the 15 questions. Each respondent could score between 0 and 30 points. The symptom scores ranged from 4 to 20 with no apparent pattern among the groups of workers. Thus chronic symptoms do not appear to be related to workplace exposures. This indicates that there is no substantial long-term health effects among the workers due to the workplace exposures.

VII. Conclusions

Analysis of a bulk sample of the solvent indicated that it is a complex mixture of aliphatic hydrocarbons, toluene and xylene. It contains no benzene.

Sources of exposure for the cleaners include inhalation of solvent vapors and direct skin contact with the solvent-soaked cloth. Sprayers do not seem to have substantial skin contact with solvent. Air concentrations of solvents in the spray booth were not assessed and may be substantial.

Environmental sampling for airborne concentrations of solvent constituents in the breathing zones of cleaners and mounters indicated that respiratory exposures are quite low. Solvent vapors may contribute to, but are not the only source of exposure as noted above.

To assess exposure levels to the solvent from both inhalation and skin absorption, we used urinary excretion of hippuric and methylhippuric acid as a biological indicator of exposure to toluene and xylene, respectively. The former are metabolic products of the latter. Post-shift and pre-shift changes in urine concentration of hippuric and methylhippuric acid suggest that cleaners, and possibly sprayers, are exposed to solvents containing toluene and xylene. Post-shift concentrations for cleaners are higher than levels reported among non-exposed populations, but lower than levels indicative of exposure to the NIOSH recommended exposure limits. It should be noted that this biological monitoring method is capable of assessing exposure only to toluene and xylene, which constitute only 10% of the solvent. Thus these results suggest that exposure to the solvent may be substantial but the actual level cannot be determined.

Based on both health questionnaire and physical examination, we conclude that cleaners experience dermatitis involving the hands and fingers due to direct skin contact with the solvent-soaked cloth. Mounters also have drying and peeling of the fingers, likely due to exposure to the water-based glue.

Cleaners, and possibly sprayers, report experiencing more acute symptoms consistent with exposure to solvents, compared to the mounters and office workers. The differences are small and there is a large overlap between the group of workers. Nevertheless, these findings are consistent with the results of the biological monitoring and suggest that cleaners, and possibly sprayers, may have increased exposure to solvents.

VIII. Recommendations

NIOSH makes the following recommendations:

1. Workers who use the solvent-soaked cloth should wear a rubber or polyvinylchloride glove covering the fingers of the hand which is used to hold the cloth. The other hand may remain uncovered, if necessary to feel the surface of the album page.

2. Workers exposed to water-based glue should minimize long-term contact with glue. Protective barrier lotions and ointments may be beneficial.

3. Workers should wear protective apron, gloves, glasses, and solvent-absorbing cartridge respirator while spraying lacquer in the spray booth.

IX. References

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X. Authorship and Acknowledgement

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XI. Distribution

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati Address. Copies of this report have been sent to:

1. Leather Craftsman
2. State Health Dept.
3. Local OSHA Office

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

Table I

Exposure Criteria and Physiologic Responses for Selected Solvents

Compound	OSHA Permissible Exposure Limit (mg/M^3)	NIOSH Recommended Exposure Limit (mg/M^3)	Physiologic Response
Toluene	750[1] 11252[2] 1885[3]	375[1] 750[2]	dizziness, headache, eye irritation, dermatitis
Xylene	435[1]	435[1] 870[2]	dizziness, eye, nose throat, irritation dermatitis
Octane	2350[1]	350[1] 1800[2]	eye, nose irritation, drowsiness, respiratory irritation, dermatitis

1. Timed Weighted Average (TWA) exposure 8 hour day (OSHA), 10 hour day (NIOSH) for a 40 hour work week.

2. Ceiling exposure for 10 minutes (toluene and xylene) or 15 minutes (octane).

3. Peak exposure, not to be exceeded at any time.

TABLE II

Air Concentrations of Solvents*

Leathercraftsman - October 20, 1980

Operation	Sampling Volume (liters)	Toluene (mg/M^3)	Xylene (mg/M^3)	Hydrocarbons (mg/M^3)
Mounting	345	1.0	0.9	21
(front of room)	425	0.9	0.8	19
Cleaning	410	8.6	13.0	320
(center of room)	275	6.5	8.2	210
" "	375	2.6	2.6	50
" "	380	15.0	43.0	390
" "	445	6.8	6.4	170
(rear of room)	405	12.0	15.0	200
" "	370	20.0	56.0	155
" "	390	16.0	30.0	425

*Concentration of solvents sampled in workers' breathing zones while performing operations listed.

TABLE III: Post Shift Urinary Hippuric/Methyl Hippuric Acid Concentrations
Leather Craftsman - June 29, 1981

Group of Workers	No. in Group	Average Concentration mg/ml. mean + S.D.	Average Concentration gm/gm creatinine mean + S.D.
Cleaners	8	1.27 ± 0.97	0.79 ± 0.68
Mounters	5	1.06 ± 0.31	0.55 ± 0.41
Sprayers	3	1.04 ± 0.45	0.48 ± 0.17
Office Workers	5	0.60 ± 0.27	0.43 ± 0.30

TABLE IV

Pre-Shift to Post-Shift Change in Urine Hippuric/Methylhippuric Concentration

Leather Craftsman - June 29, 1981

Group of Workers	Number in Group	Average Change in Concentration* gr/gm creatinine mean ± S.D.
Cleaners	8	0.20 ± 0.17
Mounters	5	0.10 ± 0.09
Sprayers	3	0.48 ± 0.17
Office Workers	5	0.07 ± 0.32

*Post-shift concentration minus Pre-shift concentration of hippuric/methylhippuric acid.

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