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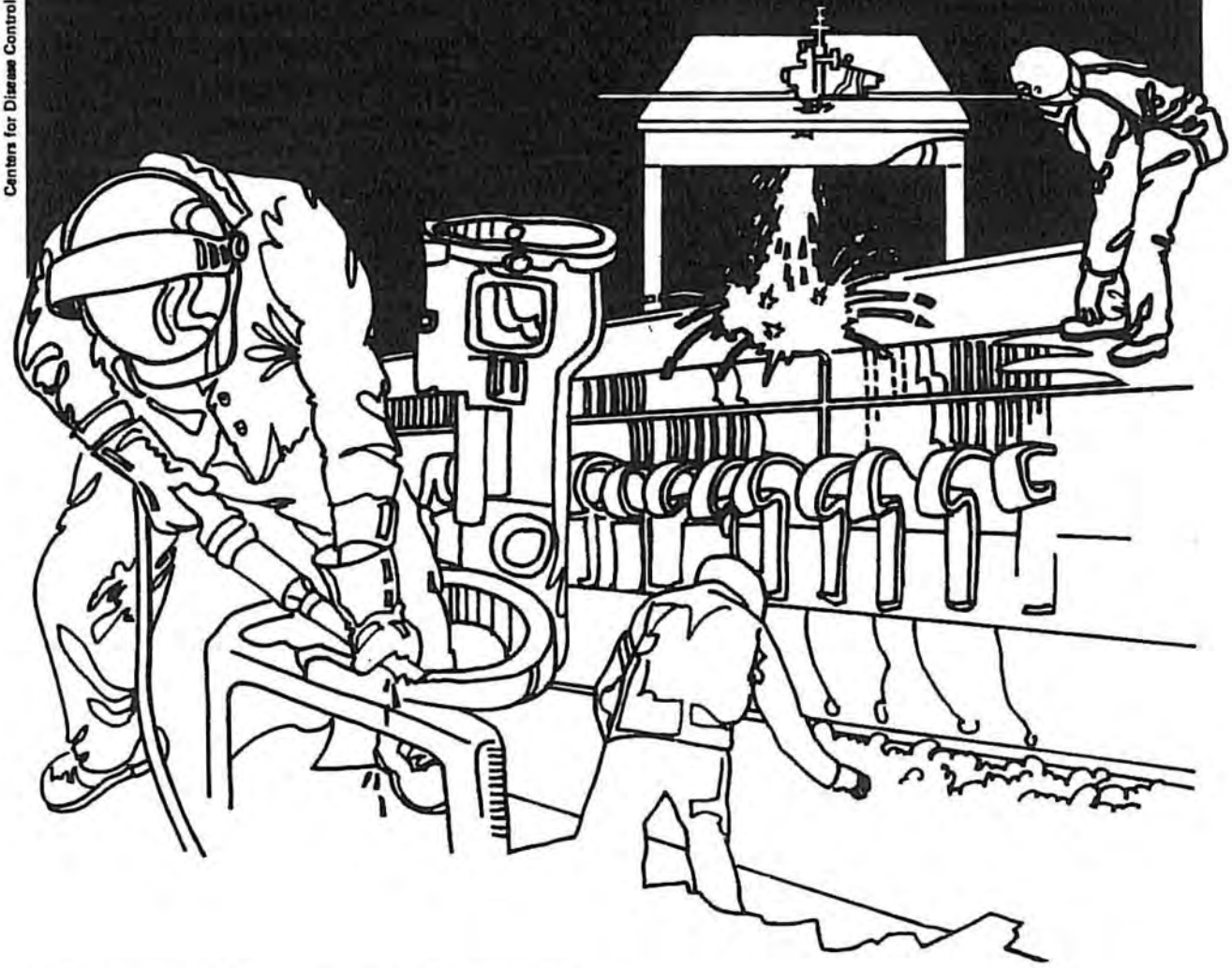

Health Hazard Evaluation Report

HE 80-167-1078
STEPHENSON AND LAWYER, INC.
GRAND RAPIDS, MICHIGAN

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.

HE 80-167-1078
March 1982
Stephenson and Lawyer, Inc.
Grand Rapids, Michigan

NIOSH Investigators:
Paul L. Johnson, I.H.
Kern Anderson

I. SUMMARY

In July, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from employees at Stephenson and Lawyer, Inc., Grand Rapids, Michigan. The request stated that workers located in the hot-wire cutting areas were experiencing lung and chest tightness, nausea, headaches, sinus problems and general breathing difficulties. In these areas, polyurethane and polyethylene foam materials are sized and shaped for distribution by 8 to 12 employees using high-temperature wires.

NIOSH investigators collected environmental samples in July and December, 1980 using both general area and personal sampling techniques to determine workplace exposure(s). Ventilation measurements were obtained to determine the efficiency of the existing exhaust systems. In addition, a follow-up medical evaluation was conducted in September 1981. During this evaluation 15 employees were interviewed using a directed health questionnaire, that focussed on health effects associated with toluene diisocyanate (TDI) exposure. Substance evaluated, respective concentrations found, and applicable criteria are reported as follows: 1,1,1-trichloroethane - range 0.7 ppm to 15.2 ppm (OSHA-350 ppm); methylene chloride - range 0.2 ppm to 18.6 ppm (NIOSH-75 ppm); ethyl acetate - range 0.1 ppm to 0.5 ppm (OSHA-400 ppm); benzene - .05 ppm (NIOSH-1.0 ppm); trichlorethylene - range 0.1 ppm to 0.5 ppm (NIOSH 25 ppm); toluene - range 0.1 ppm to 0.3 ppm (NIOSH-100 ppm); isobutyl alcohol - 0.1 ppm (ACGIH-50 ppm); xylene - 0.2 ppm (NIOSH-100 ppm); formaldehyde and other aldehydes all non-detectable; chloroethane - range 0.01 to 0.08 ppm (OSHA-1000 ppm); toluene diisocyanate - range 0.0002 to 1.03 ppm (NIOSH-0.005 ppm) and hydrogen cyanide - non-detected. It should be noted that the increased TDI level (1.03 ppm) was collected inside an exhaust booth and should not be interpreted as a personal exposure. The results from the medical evaluation indicate that six persons reported having experienced breathing difficulties associated with the inhalation of fumes from operating various hot-wire machines. The reported symptoms included shortness of breath, burning in the chest, nausea, asthma, coughing, and choking. Consistent abnormalities were identified in eight employees. Three of the 15 persons interviewed were symptomatic for TDI sensitization.

Based on the findings obtained from the environmental and medical evaluation site visits, NIOSH has determined that a health hazard probably did not exist in the hot-wire cutting area at the time of sampling, however, the environmental data indicated that TDI concentrations and possibly other organic vapors could exceed the current exposure criteria if the exhaust systems were not in use. In addition, three employees had reported health effects consistent with TDI sensitization. Recommendations for improving working conditions in the hot-wire cutting area are presented in Section VIII of this report.

KEYWORDS: SIC 3079, Foam-plastics, miscellaneous plastic products, polyurethane and polyethylene foam, hot-wire cutting, 1,1,1-trichloroethane, TDI, methylene chloride, ethyl acetate, benzene, toluene, xylene, aldehydes, chloroethane, methyl chloride.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, NIOSH investigates the toxic effects of substances found in the workplace. In July, employees at Stephenson and Lawyer, Inc. requested that NIOSH determine if hot-wire cutting operations were exposing workers to excessive concentrations of toxic substances. The request stated that employees working in hot-wire cutting areas have experienced symptoms of general breathing difficulties, nausea, headaches, coughing, occasional sinus problems, and chest tightness.

Interim Report #1, discussing the environmental findings from the July and December visits, was forwarded to the company and requestor in August 1981.

III. BACKGROUND

Stephenson and Lawyer, Inc., a 35 year old plant which employs approximately 130 production workers, functions as a fabricator of foam products. Departments housed at the facility include Sawing, Press, Hot-Wire, Buffing, Lamination, Packaging, Storage and Maintenance. In these departments sheets and/or rolls of polyurethane, and polyethylene materials are cut, sized, corrugated, and bonded to form gaskets, filters, cushions, and surgical products. Of major concern at the plant were the hot-wire cutting areas. In these areas hot wires, heated many times greater than the melting temperature of the foam materials, were adapted to cut, bore, flange, and engrave foam parts.

A fan-jet supply system consisting of a fan, housing, a motorized inlet shutter, and special overhead plenums was used to bring make-up air to the work areas. Each supply system (make-up air) was mounted to air inlet ventilators located near the ceiling along the South wall. Plenums (polyethylene tubing) were attached to the discharge end of the supply fans, and extended horizontally throughout the upper region of the building. Ventilation of the air and processing emissions was through local exhaust systems. Duct work from the main system was connected to individual booths (2' x 2' x 2') which enclose each hot-wire cutting unit. Eight to 10 hot-wire cutting units can be operated, during each shift. However, normal production generally utilizes only 2 to 5 stations for 4 to 6 hours per work shift.

IV. EVALUATION DESIGN AND METHODS

A. Evaluation Design

During the initial site visit (July 15, 1980) hot wire cutting operations were not being fully utilized. Therefore, to simulate usual work conditions two operators were instructed (by management) to process foam materials at a Briggs-trim station and at a Cobe-hole cutting station (both hot-wire cutting stations). Both cutting processes were operating for approximately 6 hours during the initial visit. During that time environmental measurements were obtained in the Glue Mixing, Adhesive Storage, New Foam Processing and peripheral Wire-cutting areas.

A 2-day follow-up evaluation (December 11-12, 1980) was conducted during routine hot-wire cutting operations. Eight cutting units were manned during this evaluation. Operators at the cutting stations were responsible for either trimming, boring, flanging or engraving foam materials. All hot-wire cutting units were stationed near or inside small exhaust booths positioned on tables directly in front of the operation. Since the environmental data obtained during the second follow up indicated a potential TDI exposure while the local exhaust systems were not operating, the decision was made by NIOSH to further evaluate the plant and any reported health effects. A medical representative from NIOSH was assigned this part of the evaluation.

On September 30, 1981 a medical evaluation was conducted at the plant. Fifteen employees, currently working (during two shifts) in the Hot-Wire Cutting Department, were interviewed using questionnaires directed at health effects associated with TDI exposure.

B. Evaluation Methods

1. Environmental Sampling

During the initial and follow-up evaluations, breathing-zone (BZ) samples were collected by securing portable vacuum monitoring pumps, equipped with various sample collection media, to the worker or their work station. Since worker activities were somewhat stationary, the majority of the pumps were secured on the hot-wire cutting booths while the sample collection media were placed near the workers' breathing zone. General area (GA) air samples were collected by placing battery- powered vacuum pumps and sample collection media in areas adjacent to the work activities. All sampling was conducted during the day shifts since this time period utilized the majority of the workers and their processing operations.

a. Air Samples

Exposures to chloroethane, methylene chloride, 1,1,1-trichloroethane, ethyl acetate, benzene, trichloroethylene, toluene, xylene and isobutyl alcohol: were determined by 1) drawing air through charcoal or silica gel tubes (via vacuum pumps) at flow rates of 200-900 cc/min.; 2) desorbing the sample with carbon disulfide, and 3) analyzing the desorbed sample by using a gas chromatograph equipped with a flame ionization detector (P&CAM 127).

Samples for formaldehyde, acetaldehyde, propionaldehyde, n-butyraldehyde, and n-valer-aldehyde were collected by bubbling air at 1.0 liter per minute (lpm) through an impinger containing 15 ml of sodium bisulfite. Analysis of these samples was performed by using a Hewlett-Packard 5730A gas chromatograph equipped with a flame ionization detector. A 3'X1/8" stainless steel column packed with Chromosorb 101 was used with the oven programmed from 80°C to 160°C at a rate of change of 8°C/min. The method of absorption used was a 1% $NaSO_3$ solution.

Samples for hydrogen cyanide were collected by bubbling air at 1.0 lpm through an impinger containing 10 ml of sodium hydroxide. Analysis was performed by using the cyanide ion specific electrode (P&CAM 116).

Samples for Toluene diiocyanate (TDI) were collected by bubbling air at 1.0 lpm through midget impingers containing 15 ml of absorbing solution (P&CAM 141). Analyses of these samples were performed by use of spectrophotometric techniques.

b. Ventilation

The efficiency of the local exhaust systems at each hot-wire cutting station was quantitatively evaluated by measuring air velocities with a velometer and qualitatively using smoke tube techniques.

2. Medical

Interviews were conducted and directed health questionnaires were administered to 9 employees currently working in the Hot Wire Cutting Department, 5 persons who were previously employed in the department and one person who no longer worked at the plant. Those interviewed ranged in age from 21 to 58 years with a mean age of 46 years. The length of employment (in the Hot Wire Dept.) among this group ranged from 1.5 to 19 years with a mean of 5.5 years.

V. EVALUATION CRITERIA

A. Environmental Criteria

To assess the concentrations of air contaminants found in the place of employment, three primary sources of criteria are used (Table I): 1) NIOSH criteria for recommended standards for occupational exposure to substances (Criteria Documents), 2) recommended and proposed Threshold Limit Values (TLV's) as set forth by American Conferance of Governmental Industrial Hygienist, and 3) Occupational Health and Safety Standards as promulgated by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (29 CFR 1910.1000).

Whenever possible, the NIOSH recommended standards are the environmental criteria applied since they represent the most recent knowledge concerning acute and/or chronic exposures. If NIOSH recommended standards do not exist, the next most stringent recommended level or legal standard is used.

B. Medical

Listed in Table I are the principal or primary health effects underlying the basis for the determination. Since TDI sensitization was indicated, a discussion of this compound is presented in greater detail.

Toluene Diisocyanate[1,2]

Polyurethanes are formed by the reaction of isocyanates with polyhydroxy compounds. Because of TDI's high volatility, exposure can occur in all phases of its manufacture and use. Exposure of humans to sufficient concentrations causes irritation of the eyes, nose, throat (a choking sensation), and a productive cough, often with restrosternal soreness and chest pain. If concentrations reach 0.5 ppm, the possibility of respiratory response is imminent.[3] Respiratory symptoms will usually develop following a 0.5 ppm exposure and a latent period of 4 to 8 hours. Higher concentrations produce a sensation of oppression or constriction of the chest; there may be bronchitis and severe bronchospasm; pulmonary edema may also occur. Nausea, vomiting and abdominal pain may complicate the presenting symptom. Upon removal from exposure, the symptoms may persist for 3 to 7 days.[4] Sensitization in susceptible individuals after repeated exposures may occur at levels as low as 0.02 ppm.[3] Symptoms include nocturnal (night) cough and nocturnal dyspnea (shortness of breath) with progression to asthmatic bronchitis. If the worker has been hospitalized or otherwise removed from the worksite, a return to work may cause a severe asthmatic attack immediately or within a few hours. In other instances patterns of sensitization, workers who had only minimal upper respiratory symptoms or no apparent effects from several weeks of low level exposure can suddenly develop acute asthmatic reaction to the same or slightly higher levels.[4]

VI. RESULTS AND DISCUSSION

A. Environmental

1. Hot-wire cutting stations

Interviews with both management and production personnel indicated that the worker(s) manned the hot-wire cutting stations only part of the scheduled 40-hour work week. A sample obtained from inside an exhaust booth which housed a hot-wire cutting unit did indicate a potential for

overexposure (Table IV). From the 135-minute sampling period, toluene diisocyanate (TDI) was measured at 1.03 ppm, which is 51 times the present (OSHA 0.02 ppm) enforceable standard. Although this concentration did not represent an exposure situation on the day sampled, it is indicative of airborne TDI concentrations if there was no local exhaust ventilation. Very low concentrations of TDI were detected in the workroom air 0.0002-0.0004 ppm (Table IV).

2. Adhesive spraying booths

An increased exposure potential was also found at the adhesive spraying booth located near the hot-wire cutting stations. At this booth short-term methylene chloride samples (obtained using detector tubes) resulted in 2 samples (100 ppm each) exceeding the NIOSH 75 ppm recommended standard. Both samples were collected during spraying while the exhaust system was not operating. Levels decreased to less than 10 ppm (Table II) when the ventilation system was in operation. The long-term methylene chloride samples collected at various locations throughout the plant ranged from 0.1 to 18.6 ppm (Tables III & V).

All other compounds detected were less than 5% of the current legal (OSHA) and recommended (NIOSH/ACGIH) criteria.

3. Exhaust booths

The exhaust hoods were designed to enclose the contaminant source and induce an air movement which would prevent the contaminant from escaping the enclosure. ACGIH recommends 65 to 100 ft/min as minimum control velocities for undisturbed locations (exhaust booths).[5] The exhaust booths enclosing the hot-wire cutting devices maintained air velocities of 50 feet per minute (ft/min) eight inches from the hood to 350 ft/min (face, center of booth opening).

Smoke tube test showed all systems, with the exception of Area 205-3 (Table VI), to have sufficient exhausting potentials. The noted inefficiency may have been due to a clogged filter or a disconnected exhaust line.

4. Employee interviews/experiences

Employees responsible for hot-wire cutting operations were interviewed during the environmental survey, in an effort to correlate personal symptoms with workplace exposures. Those interviewed indicated they experienced headaches, nausea, dry throats, sinus problems, and had noted odors similar to that of airplane glue and/or dry cleaned clothes. Since an adhesive spraying station was located near the hot-wire

cutting operations, and toluene and 1,1,1-trichloroethane, which are associated respectively with airplane glue and dry cleaning odors, were detected, these materials may be the basis for the noted odors.

The above findings indicate that the operation and maintenance of work area exhaust ventilation is of major importance in reducing airborne contaminants. Effective local as well as general exhausting systems must be allowed to operate continuously regardless of process duration (i.e. foam cut testing of short production runs). Foam cut testing and/or paint spraying of sample or excess materials were often processed while the ventilation system was not operating. Employees stated that they sometimes forget to turn the system on or that it was too much trouble when spraying or cut testing only 1 or 2 form pieces.

B. Medical

In response to a series of questions intended to elicit histories of respiratory problems, consistent abnormalities were identified in eight employees. These employees reported having experienced shortness of breath when hurrying on level ground or walking up a slight incline. They also reported periodic sleep disturbance due to shortness of breath. The respondants ranged in age from 21 to 58 years, with a mean age of 46 years. Their length of employment (Hot Wire Cutting Dept.) ranged from 1.5 to 19 years, with a mean employment length of 5.5 years.

Eight individuals reported persistent coughing - seven of whom reported having experienced sleep disturbances due to nocturnal coughing. Histories of wheezing and tightness in the chest were reported by seven and eight individuals respectively. The occurrence of symptoms was most commonly associated with operation of the "Briggs, AC, Vertrol and Hot-Pin" machines. The typical onset of symptoms were characterized by coughing, wheezing and shortness of breath followed by tightness in the chest (towards the end of the work-day). Difficulty getting to sleep or maintaining uninterrupted sleep resulted from the persistence of symptoms. The frequency and severity of symptoms varied among individuals, probably due to job rotation and varying degrees of TDI sensitization. Some individuals reported the onset of symptoms after working one shift on a given machine, while others reported the "building-up" of symptoms if they operated a specific machine for two to three consecutive days. Most of the symptoms in the affected persons reportedly disappear spontaneously, although two individuals have severe and chronic asthmatic conditions. At the time of the survey three individuals were symptomatic for TDI sensitization.

Among other irritant symptoms, a runny or stuffy nose occurred almost daily, as reported by 10 different individuals. Eight individuals reported experiencing occasional and varying degrees of burning eyes and/or throat. The occurrence of these symptoms was also associated with excessive fume concentration and attributed to clogged exhaust systems (hot-wire cutting area). Most employees interviewed reported substantial reduction of fumes after the exhaust pipes and fans had been cleaned. The improved conditions, however, last only for a few days.

VII. CONCLUSIONS

The potential for exposure(s) to TDI, MeCL, 1,1,1,-TCE and other organic vapors increases if the exhaust systems are not operating or properly maintained. From the evaluation it appeared that there may have been days when the exhaust system(s) were not used and vapor concentration(s) were sufficient to cause respiratory and other irritant symptoms. Although job rotation can help minimize employees' exposure to the "problem" machines, it seemed apparent that the exhaust system(s) were not properly maintained and a group of employees had developed varying degrees of TDI sensitization.

VIII. RECOMMENDATIONS

1. A training program should be implemented to make employers and employees aware of potential contaminants, their sources and a means of protection from overexposure.

2. Employees located at the hot-wire cutting stations should be encouraged to report any symptoms or irritation experienced which result from workplace activities. Such complaints may indicate that the local exhaust is malfunctioning.

3. Drums of solvents and adhesive mixtures should not be left open at any time.

4. Exhaust systems should be operable at all times during spraying of adhesives, painting and hot-wire cutting.

5. All exhaust systems should be cleaned (filters changed) and maintained on a regular basis. Disconnected or plugged tubing (area 205-3, Table VI) can greatly reduce the overall efficiency of the exhaust system.

6. Consider equipping the hot-wire cutting booth exhaust ducts with an accessible duct filter which can be easily removed for cleaning. Such a filtering addition would eliminate the need for removal of the duct system(s) during routine cleaning and maintenance.

7. Physical examinations are not currently a prerequisite for employment. At the request of management, a protocol for pre-employment physical examinations will be forwarded by NIOSH (HETAB Medical Section).

8. Periodic check-ups or medical examinations should be made available to those employees experiencing TDI sensitization.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Paul Johnson
Industrial Hygienist
Industrial Hygiene Section

Kern Anderson
Medical Assistant
Medical Section

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

Report Typed By: Jackie Woodruff
Betty Widener
Clerk-Typist
Industrial Hygiene Section

XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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Copies of this report have been sent to:

1. Stephenson & Lawyer
2. Requestor
3. OSHA, Region V
4. NIOSH, Region V

TABLE I

Environmental Evaluation Criteria

Stephenson and Lawyer, Inc.
Grand Rapids, Michigan
HE 80-167

December 11, 1980

SUBSTANCE	RECOMMENDED ENVIRONMENTAL LIMIT	SOURCE	PRIMARY HEALTH EFFECTS	OSHA STANDARD
	In ppm*			
1,1,1-trichloroethane	350-ceiling	NIOSH/ACGIH	Nervous system, Liver, and Heart, Irritating to the eyes and skin, - carcinogenic in rats and mice	350
Methylene Chloride	75	NIOSH	Central Nervous system depressant, eye, skin, and respiratory tract irritant	500
Ethyl Acetate	400	ACGIH	Respiratory tract irritant, can cause sensitization	400
Benzene	1-60 min. ceiling	NIOSH	Causes cancer, associated with leukemia, central nervous system depressant, dermatitis	10
Trichloroethylene	25	NIOSH	Central nervous system, cardiovascular, liver and kidney effects, eye and skin irritiant, suspect carcinogen	100
Toluene	100	NIOSH/ACGIH	Central nervous systems depressant, skin irritant	200
Isobutyl Alcohol	50	ACGIH	Narcosis, mild skin irritant	100
Xylene	100	NIOSH/ACGIH	Eye, ear, nose and throat, and skin irritant, can cause chemical pneumonitis and pulmonary edema	100
Chloroethane	1000	ACGIH	Mild eye and skin irritant, can cause inebration	1000
Aldehydes				
1)formaldehydes	1	NIOSH	Strong skin, eye and respiratory	3
2)acetaldehyde	100	ACGIH	tract irritants, can cause	200
3)n-Valeraldehyde	50	ACGIH	sensitization, formaldehyde is a potential human carcinogen	---
Hydrogen Cyanide	4.7-10 min ceiling	NIOSH	Intensely poisonous-no forewarning at increased concentrations, at lower levels has "bitter almond" scent	10

* Concentrations in parts per million parts of air (ppm).
All concentrations are time-weighted average (TWA) exposures for a normal (8-to-10 hours) workday, except ceiling limits noted.

TABLE II

Results[1] of Screening (detector tube) Samples

Stephenson and Lawyer, Inc.
Grand Rapids, Michigan
HE 80-167

December 11, 1980

Location	Toluene	Chlorine	Methylene Chloride	Trichloroethane	Formaldehyde
Adhesive Storage Area	ND	ND	20 ppm[1]	30 ppm	ND
Adhesive Spraying	ND	ND	100 ppm*	75 ppm*	ND
Hot-Wire Cutting	ND	ND	100 ppm	75 ppm	ND
Adhesive Spraying	ND	ND	10 ppm**	10 ppm**	

* The exhaust was not operating while spraying.
** Management turned on exhaust system.
*** Materials being sprayed were composed of Methylene Chloride and Trichloroethane.
1. Concentrations are in parts per million parts of air.
2. Detection range: 50-1000 ppm.
3. Detection range: 50-600 ppm.

TABLE III

Results of Long-term Samples Collected at

Stephenson and Lawyer, Inc.
Grand Rapids, Michigan
HE 80-167

December 11, 1980

Location/ Sample Description	Sample Volume (Liters)	Time	RESULTS REPORTED BELOW ARE PARTS PER MILLION (ppm) 1,1,1-TCE[1]	MeCl[2]	EtAc[3]	Bz[4]	TCEy[5]	Tol[6]	IBOH[7]	Xy[8]
Hot-wire whole cutting	72	11:45-17:50	1.6	0.2	0.1	ND	ND	0.2	ND	ND
Hot-wire Briggs Trim Mach.	74	11:45-17:50	1.0	0.2	0.2	ND	ND	0.2	ND	ND
Glue mixing Area	65	12:04-17:50	0.7	0.5	0.9	ND	ND	0.3	ND	ND
Hot-wire cutting Cobe	49	12:00-16:00	2.0	0.1	ND	ND	ND	0.3	ND	ND
Adhesive Storage	71	11:55-17:50	ND	ND	ND	ND	ND	ND	ND	ND
New Foam Processing Area	135	11:30-14:00	ND	ND	ND	ND	ND	ND	ND	ND
New Foam Processing Area	135	11:30-14:00	5.0	ND	ND	ND	0.5	0.1	0.1	ND
Adhesive Storage	69	12:05-17:50	2.1	0.2	ND	.05	0.1	0.2	ND	0.2

1 1,1,1-TCE = 1,1,1-Trichloroethane
2 MeCl = Methylene Chloride
3 EtAc = Ethyl Acetate
4 Bz = Benzene
5 TCEy = Trichloroethylene
6 Tol = Toluene
7 IBOH = Isobutyl Alcohol
8 Xy = Xylene

*Since the worker's activities were somewhat stationary, the majority of the samples were collected by securing a sampling pump at the work station and then placing sampling media at or near the worker's breathing zone.

No individual limits of detection were reported for these samples.

TABLE IV

Results of Toluene Diisocyanate Samples *

Stephenson and Lawyer, Inc.
Grand Rapids, Michigan
HE 80-167

December 11, 1980

LOCATION/SAMPLE DESCRIPTION	TIME	SAMPLE VOLUME (liters)	TOLUENE DIISOCYANATE (ppm)
Hot-wire cutting area 205(1) Briggs machine	7:00am 2:35pm	682	ND**
Hot-wire cutting area Workstation 211	7:00am 2:35pm	682	ND
Hot-wire cutting area 205(3)	7:00am 2:35pm	682	ND
Hot-wire cutting area 210(3)	7:00am 2:35pm	682	ND
Hot-wire cutting area 210(2)	7:00am 2:35pm	682	2.0×10^{-4} (.0002)
Hot wire cutting area 210(1)	7:00am 2:35pm	682	4.1×10^{-4} (.0004)
Hot-wire cutting area Workstation 275	7:35am 2:32pm	682	ND
Hot-wire cutting station 205(3) Inside exhaust booth	12:10pm 2:35pm	219	1.03***
Hot-wire cutting area Workstation 230	12:10pm 2:35pm	219	ND

Limit of detection was 1.0 microgram per sample (.0002 ppm).

* Since the workers' activities were somewhat stationary, the majority of the samples were collected by securing a sampling pump at the work station and then placing sampling media at or near the workers' breathing-zone.

** ND = Non-detectable, OSHA Standard: 0.02 ppm (ceiling), NIOSH Standard: 0.005 ppm

*** This sample was taken in the back of a booth where the exhaust duct was attached to the booth; therefore, it did not represent an exposure situation

TABLE V

Results of Chloroethone, Methylene Chloride and 1,1,1-Trichloroethane Samples

Stephenson and Lawyer, Inc.
Grand Rapids, Michigan
HE 80-167

December 11, 1980

LOCATION/SAMPLE DESCRIPTION	TIME	SAMPLE VOLUME (liters)	CHLOROETHANE	METHYLENE CHLORIDE	1,1,1-TRICHLOROETHANE
Adhesive/paper for foam backing work-station 505 (6" from trough)	7:20am 2:45pm	93	0.1	18.6	15.2
Hot-wire cutting area Workstation 210(2)	7:20am 2:40pm	88	ND*	4.9	3.1
Lathe-table cutting area Workstation 435	7:10am 2:40pm	90	0.04	4.2	3.3
Oil/lube area Workstation 207	7:15am 2:40pm	91 90	0.04 0.08	3.8 3.0	3.0 3.1

* ND = Non-detectable

** Since the workers' activities were somewhat stationary, the majority of the samples were collected by securing a sampling pump at the work station and then placing sampling media at or near the workers' breathing zone.

The limits of detection was 0.01 mg per sample for chloroethane and 1,1,1-trichloroethane and 0.02 mg per sample for methylene chloride.

TABLE VI

Hot-Wire Cutting Operators
Exhaust Measurements

Stephenson and Lawyer, Inc.
Grand Rapids, Michigan
HE 80-167

December 11, 1980

Location	Size of Hood	Location	Velocity (ft/min)
Area 211	14" x 16"	Next to booth* (8" away)	125 - 150
211	14" x 16"	Booth connected to main hood	50 - 75
205 (1)	16" x 16"	Side booth*	50 - 125
	18" x 16"	One inch from booth hood	250 - 350
210 (3)	18" x 14"	4" from booth hood	100 - 175
210 (2)	18" x 16"	Booth at side of cutting*	100 - 125
210 (2)	18" x 12"	One inch from booth hood	150 - 175
210 (2)	18" x 12"	6" from booth hood	75 - 150
210 (1)	18" x 18"	Booth at side (bottom)*	25 - 35
210 (1)	18" x 18"	One inch from booth hood	250 - 375
210 (1)	18" x 18"	8" from booth hood	100 - 175
205 (2)	16" x 18"	Side booth*	50 - 75
205 (2)	18" x 12"	2" from booth hood	100 - 175
205 (1)	18" x 16"	Side booth*	50 - 75
205 (1)	18" x 12"	2" from booth hood	100 - 125
205 (3)	16" x 16"	At duct opening face-clogged filter or disconnected line	25 - 50

* Curtain arranged to formulate a booth-like enclosure.