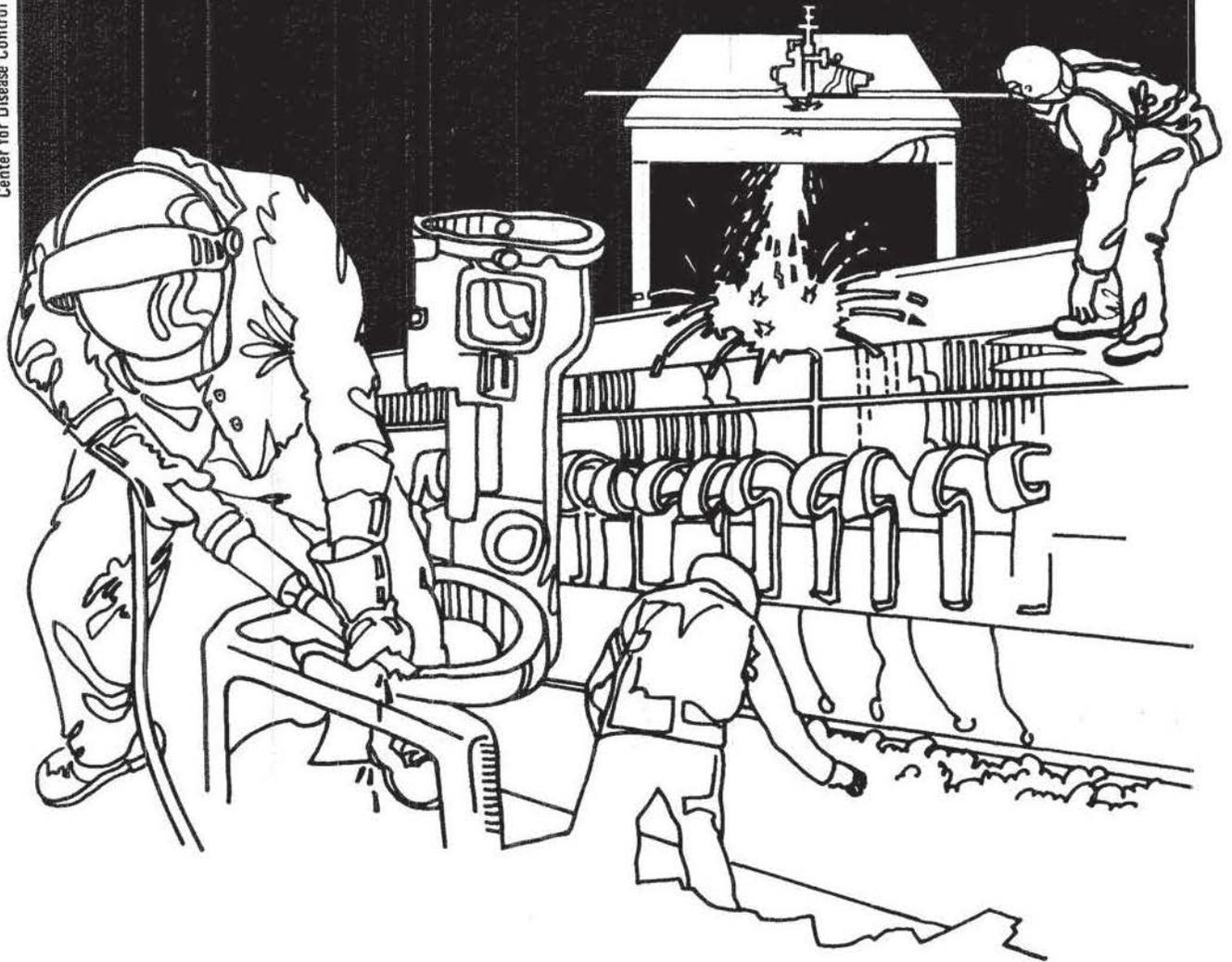


U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service
Center for Disease Control • National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

80-109-750

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. 699(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.

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

HE 80-109-750
October 1980
Beaver Shoe Company
Division of Kinney Shoe Corporation
Beaver Springs, Pennsylvania

NIOSH INVESTIGATORS:
Walter Chrostek, IH
Mitchell Singal, MD

I. SUMMARY

On April 7, 1980, NIOSH received a request from the employees of Beaver Shoe Company for a health hazard evaluation. The request expressed concern about the toxicity of the solvents and cements used in the manufacturing of shoes.

An initial walk-through survey, during which non-directed medical questionnaires were administered to the sole and bottom cementers and the treeing operators, was conducted on April 29 and 30, 1980. There are twenty employees engaged in operations where there is an exposure to solvents and cements. Personal air samples to determine worker exposure to solvent mixtures were collected on July 8 and 9, 1980.

Analysis of the seventeen samples collected at the cementing and treeing operations indicated that there is an employee overexposure to acetone, methyl ethyl ketone (MEK) and toluene mixtures at the sole and bottom cementing operations. As calculated by the formula for mixtures, five samples exceeded NIOSH recommended standard (1.01-1.79).

Eighteen employees were interviewed, ten cementers and eight blemish removers. All interviewees were women except for one cementer. Five of the eight blemish removers reported some work-related health problems (four currently, one only in the past), all attributed to solvents. Two persons reported dermatitis; the other reported mucous membrane irritation, headache, or unspecified symptoms. Six of the ten cementers reported work-related health problems, mostly eye or mucous membrane irritation. Symptoms in both groups are compatible with substances the employees are exposed to (predominantly acetone, methyl ethyl ketone and toluene).

On the basis of the data obtained in this investigation, NIOSH determined that a hazard from overexposure to organic solvent vapors (acetone, MEK and toluene), did exist at the sole and bottom cementing operations. Recommendations, along with a discussion of the work practices, have been incorporated into this report as a guide in controlling exposure to the organic solvents at the sole and bottom cementing operations.

KEYWORDS: SIC 3144 (Women's footwear), acetone, MEK, toluene, hexane, methyl isobutyl ketone, dermatitis, mucous membrane irritation, headache, unspecified symptoms.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, NIOSH investigates the toxic effects of substances found in the workplace. On April 7, 1980, a request was submitted by the employees of Beaver Shoe Company, Beaver Springs, Pennsylvania, expressing concern about the toxicity of the solvents and cements used in the manufacturing of shoes.

III. BACKGROUND

Beaver Shoe Company is engaged in the production of women's shoes from sheet leather or plastic and preformed parts. The sheets are pattern cut, box toe cemented where a thermoplastic is applied to the toe (electric heat). These pieces go to the die cutting machines, to latex cementing, trimming, lasting (where the insoles are cemented), counter dipping, thermoplastic lasting, combination lasting (toe, heel and sole), forming, heel nailing, bottoming, roughing and pounding, bottom cementing, shanking, sole cementing and treeing.

Of the 350 employees at this plant, four are engaged in sole cementing, six in bottom cementing and eight in treeing. These employees are exposed to organic solvents from cements and cleaning solvents.

On April 29 and 30, 1980, the NIOSH Regional Industrial Hygienist met with representatives of the company and the employees for the opening and closing conference, walk-through survey and conducted non-directed medical interviews.

An interim report was sent May 1980 to plant management and the representative of the employees, it included the findings of the initial survey, recommendations to modify the local exhaust ventilation and NIOSH's future plans.

IV. EVALUATION DESIGN AND METHODS

Five bulk samples of the most used solvents were collected for benzene analysis. The results showed no benzene was present in two samples. In three of the samples, the amount of benzene present was less than 0.10 percent of the total bulk, and therefore no sampling was done for this contaminant.

On July 8 and 9, 1980, environmental air samples were taken on charcoal tubes utilizing personal air sampling pumps operating at approximately 100 cubic centimeters per minute.

The A and B sections of the sample charcoal tubes were separately desorbed each in one ml carbon disulfide containing one ul per ml undecane as an internal standard. The samples were analyzed by gas chromatography following a modification of NIOSH Method P&CAM 127(1) using a Hewlett-Packard 5731A gas chromatograph equipped with a flame ionization detector. A 12' X 1/8" stainless steel column packed with 10% Tergitol np-35 on 80/100 mesh Chromosorb W(AW) was used with oven temperature programming from 67°C to 120°C at a rate of 4°C/minute.

The limit of detection was 0.01 mg/sample for hexane, MEK, MIBK and toluene. It was 0.05 mg/sample for acetone.

V. EVALUATION CRITERIA

<u>Substance*</u>	<u>OSHA</u> ⁽²⁾	<u>NIOSH</u> ⁽³⁾
Acetone	2400	590
Methyl Ethyl Ketone	590	590
Toluene	750	375 (skin)**
Hexane	1800	360
MIBK	410	200

* Denotes milligrams of contaminant per cubic meter of air sampled.

** Potential contribution to the overall exposure by the cutaneous route including the mucous membrane and eye.

The diluents in the cements and the spotting solutions used at the treeing operation are mixtures of organic solvents. Atmospheric samples that were collected were analyzed for the individual components of the air contaminant.

In order to determine if there were overexposures to mixtures of organic solvents, the following formula was used:

$$\frac{C^1}{T^1} + \frac{C^2}{T^2} + \dots + \frac{C_n}{T_n}$$

where C^1 is the observed atmospheric concentration and T^1 the corresponding threshold limit value. If the sum of the fractions exceeds unity (1), then the threshold limit of the mixture should be considered as being exceeded. The formula is only used when the chief effects are in fact additive, which they were in this case.

A. Acetone, Methyl Ethyl Ketone (MEK), Methyl Isobutyl Ketone (MIBK)⁽⁴⁾

These solvents may produce a dry scaly, and fissured dermatitis after repeated exposure. High vapor concentrations may irritate the conjunctiva and mucous membranes of the nose and throat, producing eye and throat symptoms.

In high concentrations, narcosis is produced, with symptoms of headache, nausea, light headedness, vomiting, dizziness, incoordination, and unconsciousness.

Recent reports indicate that exposure of workers to methyl n-butyl ketone has been associated with the development of peripheral neuropathy.

B. Toluene⁽⁴⁾

Toluene may cause irritation of the eyes, respiratory tract, and skin. Repeated or prolonged contact with liquid may cause removal of natural lipids from the skin, resulting in dry, fissured dermatitis. The liquid splashed in the eyes may cause irritation and reversible damage.

Acute exposure to toluene predominantly results in central nervous system depression. Symptoms and signs include headache, dizziness, fatigue, muscular weakness, drowsiness, incoordination with staggering gait, skin paresthesias, collapse and coma.

C. Hexane⁽⁴⁾

Hexane is an aliphatic hydrocarbon. It is an asphyxiant and central nervous system depressant. Hexane has neurotoxic properties. Another common effect is irritation of the skin and mucous membranes of the upper respiratory tract. Repeated and prolonged skin contact may result in dermatitis, due to defatting of the skin. Due to its low viscosity, aspiration of the liquid may result in diffuse chemical pneumonitis, pulmonary edema and hemorrhage.

VI. RESULTS AND DISCUSSION

Eighteen employees were interviewed, ten cementers and eight blemish removers. All interviewees were women except for one cementer. Five of the eight blemish removers reported some work-related health problems (four currently, one only in the past), all attributed to solvents. Two persons reported dermatitis; the others reported mucous membrane irritation, headache or unspecified symptoms. Six of the ten cementers reported work-related health problems, mostly eye or mucous membrane irritation. Symptoms in both groups are compatible with substances the employees are exposed to (predominantly acetone, methyl ethyl ketone, and toluene).

Exposures to Acetone, MEK, Toluene, Hexane and Methyl isobutyl ketone (MIBK) did not exceed their respective criteria. Since the organic solvents in the cements and cleaning solvents are mixtures of organic solvents viz., Acetone, MEK, and Toluene or Acetone, Hexane, MIBK and Toluene, the formula $\frac{C^1}{T^1} + \frac{C^2}{T^2} + \dots + \frac{T_n}{T_n}$ was used to determine if exposure to acceptable levels were exceeded.

Utilizing the formula for mixtures it was determined that exposure to Acetone, MEK and Toluene, five samples exceeded NIOSH criteria (1.01-1.79) at the sole and bottom cementing operations (Table I). Environmental exposure to a mixture of Acetone, Hexane, MIBK and Toluene exposures were within the acceptable levels (Table II).

At these operations, two conditions were observed which contributed to overexposure and were brought to the attention of management and recommendations are included in this report.

At one of the operations, sole cementer, no local exhaust ventilation system was present. Following the cementing of the soles, they are placed on racks. These racks are allowed to accumulate adjacent to the individual's work area and emit vapors. It was recommended to management that all cementing operations be moved to areas where the maximum local exhaust is present and also the rack, when full, should be moved to an area where a 40-inch-roof exhaust fan is located.

At the spotting operation (Tree Department), some work-related health problems were reported. During the evaluation of July 8-9, 1980, all exposures were below the acceptable criteria, however, production was below normal and employees

did not work a full eight-hour shift. With an increase in production exposures at these operations should be reevaluated.

At the present there are no preplacement nor periodic medical examination of employees.

VII. RECOMMENDATIONS

- 1) All employees **who** have contact with cements or cleaning solvents should be supplied and required to wear impervious gloves. With certain solvents there is an overall exposure by the cutaneous route.
- 2) Establish a labeling program for all solvent containers. Pertinent information on labeling was supplied with the Interim Report.
- 3) Modify the design of the local exhaust ventilation systems at the cementing machines. This was discussed with management.
- 4) All **cementing** machines should be located in areas where local exhaust ventilation is available.
- 5) Establish an area where exhaust ventilation is present for cement drying. Racks filled with cemented soles and uppers should be promptly removed to this area and not accumulate at the cementing machines. Recommendations 4 and 5 were discussed with management.
- 6) Establish a preplacement and periodic medical monitoring program for all employees exposed to solvent vapors.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Acknowledgements

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IX. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, OH 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, VA. 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. Beaver Shoe Company, Beaver Springs, PA
2. Employee Representative
3. NIOSH, Region III
4. OSHA, Region III

For the purpose of informing the 20 employees of the results of the Beaver Shoe Company survey, the employer shall promptly "post" for a period of 30-calendar-days the Determination Report in a prominent place(s) near where employees work.

X. REFERENCES

1. NIOSH Manual of Analytical Methods, Volumes 1 & 2, (NIOSH) Publication #77-157A & B, 1977.
2. U.S. Department of Labor, Occupational Safety and Health Administration, Federal Register, Volume 39, No. 125, June 27, 1974, (Revised No. 7, 1978).
3. NIOSH Criteria for a Recommended Standard, Occupational Exposure to Methylene Chloride, Publication #76-138, March 1976 (NIOSH).
4. Occupational Diseases: A Guide to Their Recognition, USPHS, CDC, NIOSH, Publication #77-181, Revised June 1977.
5. Threshold Limit Values for Chemical Substances in Workroom Air, American Conference of Governmental Industrial Hygienists, 1979, Cincinnati, Ohio.

TABLE I

BEAVER SHOE COMPANY
Division of Kinney Shoes Corporation
Beaver Springs, Pennsylvania
HHE 80-109

July 8-9, 1980

Results of Personal Air Samples for Organic Vapors

Date	Sample #	Job Description	Sample Period	Airborne Concentrations*			Acceptable Levels** for Mixtures			
				Acetone	MEK	Toluene	OSHA	NIOSH	ACGIH	
July 8	1	Sole Layer	07:13-13:35	133	54	111	0.30	0.62	0.45	
	2	Sole Layer	07:13-13:40	138	56	157	0.37	0.75	0.58	
	5	Sole Cementer	07:20-14:50	180	27	171	0.36	0.82	0.59	
	6	Sole Cementer	07:20-11:55	330	29	364	{0.72	1.79	1.19	
	17	Sole Cementer	11:55-14:50	779	37	395				
	8	Bottom Cementer	07:25-14:55	150	2	143	0.25	0.36	0.44	
	9	Bottom Cementer	07:28-11:30	486	294	227	{0.72	1.45	0.95	
	16	Bottom Cementer	12:00-14:55	395	146	146				
	15	Bottom Cementer	08:40-11:20	647	21	250	0.63	1.69	0.99	
	14	Bottom Cementer	11:20-14:45	845	27	286				
	July 9	22	Bottom Cementer	07:15-14:10	174	174	163	0.58	1.01	0.79
		23	Bottom Cementer	07:17-14:10	109	39	41	0.17	0.36	0.26
		24	Sole Layer	07:20-14:06	96	62	85	0.40	0.76	0.64
		25	Sole Cementer	07:21-11:20	544	26	293	{0.64	1.66	1.00
30		Sole Cementer	11:20-14:10	706	55	347				
26		Sole Cementer	07:25-11:20	468	32	162	{0.37	0.98	0.54	
31		Sole Cementer	11:45-14:16	388	33	171				
29		Sole Layer	07:40-14:06	85	44	153	0.31	0.62	0.52	
7		Sole Cementer	07:23-14:00	225	14	105	0.25	0.90	0.51	

* Denotes milligrams of contaminant per cubic meter of air samples.

** Denotes that if the sum of the following fractions: $\frac{C^1+C^2+\dots+C_n}{T^1 T^2 T_n}$ exceeds unity, then the acceptable level of the mixture should be considered as being exceeded.C¹= observed atmospheric concentrationT¹= threshold limit

EVALUATION CRITERIA

Substance	OSHA	NIOSH	ACGIH
Acetone	2400	590	2400(1780)***
Methyl Ethyl Ketone	590	590	590
Toluene	750	375(Skin)****	375(skin)

*** Intended change

**** Potential contribution to the overall exposure by the cutaneous route including the mucous membrane and eye.

TABLE II

BEAVER SHOE COMPANY
 Division of Kinney Shoes Corporation
 Beaver Springs, Pennsylvania
 HHE 80-109

July 8-9, 1980

Results of Personal Air Samples for Organic Vapors
 Airborne Concentrations*

Date	Sample #	Job Operation	Sample Period	Airborne Concentrations*				Acceptable Levels for Mixtures**		
				Acetone	Hexane	MIBK	Toluene	OSHA	NIOSH	ACGIH
7/8/80	3	Spotter (LW)	07:05-14:35	23	105	1	95	0.20	0.60	0.55
	4	Spotter (WM)	07:05-14:35	59	60	1	91	0.17	0.49	0.43
7/9/80	20	Spotter (KK)	07:10-14:05	34	183	1	157	0.32	0.99	0.94

* Denotes milligrams of contaminant per cubic meter of air samples.

** Denotes that if the sum of the following fractions: $\frac{C^1}{T^1} + \frac{C^2}{T^2} + \dots + \frac{C_n}{T_n}$ exceeds unity, then the acceptable level of the mixture should be considered as being exceeded.

C^1 = observed atmospheric concentration

T^1 = threshold limit

EVALUATION CRITERIA

<u>Substances</u>	<u>OSHA</u>	<u>NIOSH</u>	<u>ACGIH</u>
Hexane	1800	360	360(90)***
MIBK	410	200	410

*** Intended change

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