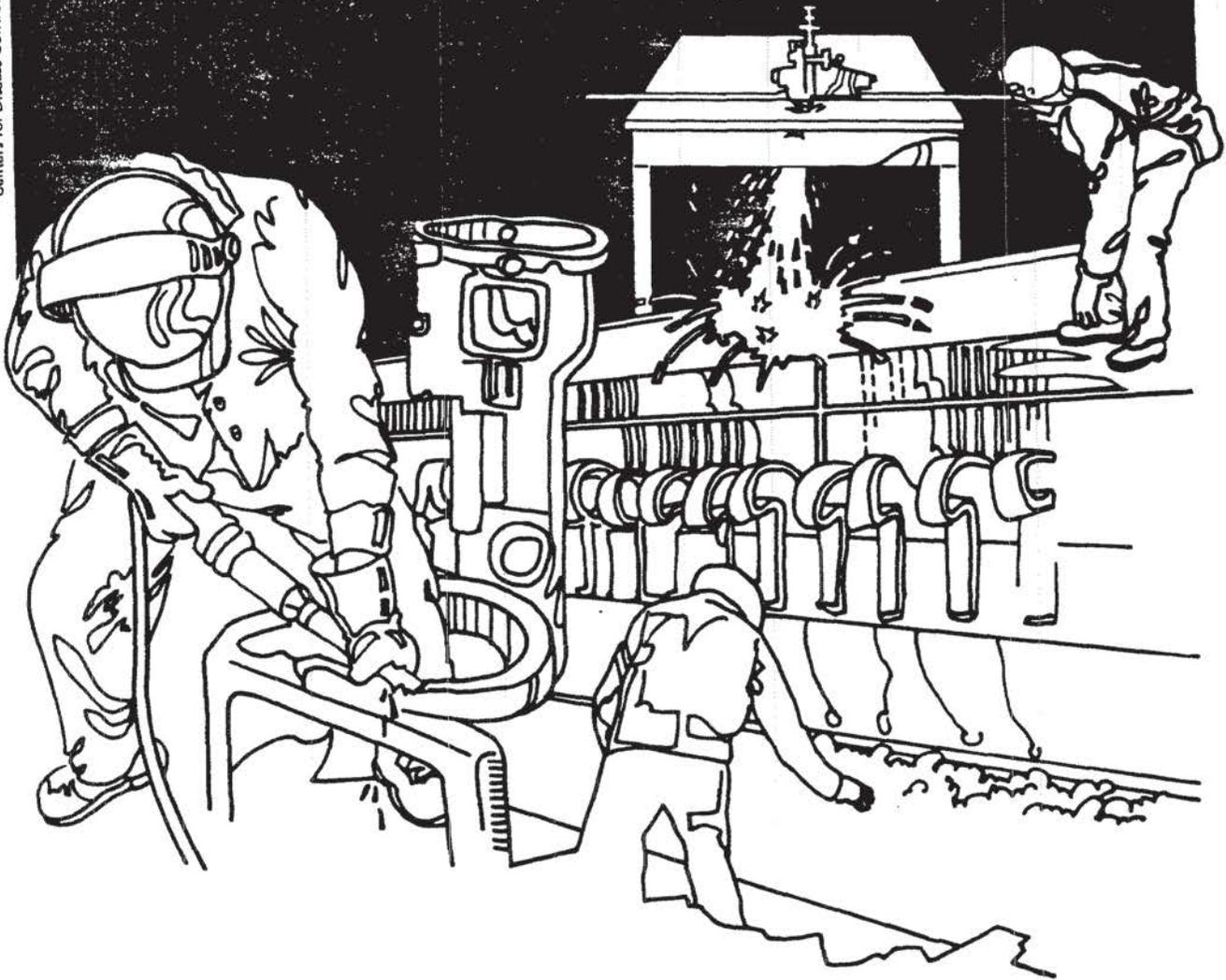


NIOSH



Health Hazard Evaluation Report

HETA 81-298-944
HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA, PENNSYLVANIA

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.

HETA 81-298-944
August 1981
Hospital of the University of Pennsylvania
Philadelphia, Pennsylvania

NIOSH Investigators:
Walter J. Chrostek, R.I.H.
William E. Shoemaker, RPC

I. SUMMARY

On April 27, 1981, NIOSH received a letter from the Director, Department of Physical Medicine and Rehabilitation, Hospital of the University of Pennsylvania requesting a health hazard evaluation. The requestor expressed concern that 3 employees had some ill health effects which they associated with operation of the oven where acrylic, polypropylene and polyethylene are softened prior to forming prosthetics.

Following the receipt of information on the types of plastics that were being processed, a walk-through survey and personal air sampling for plastic decomposition products was conducted on May 8, 1981. Bulk samples of the commonly used plastics were also collected.

Analysis of the bulk samples by the NIOSH laboratory showed the predominant decomposition products when the plastic was heated in an oven to 400° F are toluene, benzene, aliphatic (alkanes, olefins) and aldehydes (formaldehyde, acetaldehyde, propionaldehyde, n-butyraldehyde and n-valeraldehyde).

Analysis of the 2 atmospheric air samples in the work area showed that formaldehyde was present 0.46-0.90 milligram per cubic meter (mg/M³) of air. All other aldehydes were below the analytical method limit of detection.

Analysis of the 4 samples for organic vapors in the work area showed that toluene was present 1.94 to 3.87 mg/M³. All other air contaminants were minimal and could not be positively identified due to interferences.

Workroom air concentrations of toluene did not exceed NIOSH recommended or OSHA standards. Concentrations of formaldehyde were below NIOSH's former recommended exposure limits of 1.2 mg/M³, 30-minute ceiling, which was based on irritant effects. However, based upon recent evidence of carcinogenicity as reported in the Current Intelligence Bulletin #34, NIOSH recommends that formaldehyde be handled as a potential occupational carcinogen and exposures be reduced to the lowest feasible limit.

On the basis of the data obtained during this investigation, no health hazard was found from exposure to toluene during the handling and softening of the plastics. NIOSH recommends that engineering controls and stringent work practices be employed to reduce occupational exposure to formaldehyde to the lowest feasible limit.

Keywords - SIC 8922 (Noncommercial Educational, Scientific and Research Organizations, Orthotic/Prosthetic, Research) formaldehyde, toluene, general adverse health problems

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, NIOSH investigates the toxic effects of substances found in the workplace. On April 27, 1981, a letter request from the director of the Hospital of the University of Pennsylvania was received stating that employees were experiencing ill effects from working with various plastics in the INA Orthotic/Prosthetic Research Laboratory in the Piersol Rehabilitation Building.

III. BACKGROUND

The INA Orthotic/Prosthetic Research Laboratory is engaged in developing better orthopedic and prosthetic devices. During the evaluation of May 8, 1981, the employees were engaged in forming plastic legs. Nylon hose is put on a previously plaster formed leg. A proper size sheet of polypropylene, polyethylene, acrylic or polyester resin is cut. The plastic is then put on a plate previously sprayed with a silicone parting agent. The sheets are then inserted into an oven with thermal rise exhaust, and heated 5-10 minutes at 300-425° F depending on the plastic and the thickness of the sheet.

The sheet of plastic is then removed from the oven and manually stretched tightly over the mold. The excess plastic is then cut off.

General air dilution is from an open door, although a window fan in the mixing room is also available.

IV. EVALUATION DESIGN

The use of the oven is an intermittent operation. On May 8, 1981, bulk samples of plastics were collected for NIOSH laboratory analysis of the volatiles released when the samples were heated to 400° F.

Environmental air sampling was also done at the time. The samples for aldehydes were collected in impingers in series containing a 1% NaHSO₃ solution, and pumps operating at 1 liter per minute. These samples were subsequently analyzed by NIOSH method P&CAM 125¹ for formaldehyde. Analyses for acetaldehyde, propionaldehyde, n-butyraldehyde and n-valeraldehyde were done by NIOSH method P&CAM 127¹.

Environmental air samples for organic vapors were collected on porous polymer and charcoal utilizing pumps operating at 50 cubic centimeters per minute. Each charcoal tube was desorbed in 0.5 milliliter ML of carbon disulfide and each polymer sample was desorbed in 0.5 ML of n-hexane. Aliquots were injected into a gas chromatograph equipped with a flame ionization detector. Toluene was positively identified.

During this evaluation, in speaking to the 2 employees, it was brought out that they were not experiencing any ill effects from the working conditions. However, they previously experienced more than normal episodes of colds and were concerned that they may have been caused by the plastic decomposition products.

V. EVALUATION CRITERIA

| <u>Substance*</u> | <u>OSHA (2)</u> | <u>NIOSH (3-4)</u> |
|-------------------|-----------------|--------------------|
| Formaldehyde | 3.6(TWA) | LFL |
| Toluene | 750(TWA) | 375(skin)*** |

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

**Lowest feasible limit.

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

A. Formaldehyde (^{3,5,6})

Local - Formaldehyde gas may cause severe irritation to the mucous membranes of the respiratory tract and eyes. The aqueous solution splashed in the eyes may cause eye burns. Urticaria has been reported following inhalation of gas. Repeated exposure to formaldehyde may cause dermatitis from irritation or allergy.

Systemic - Systemic intoxication is unlikely to occur since intense irritation of upper respiratory passages compels workers to leave areas of exposure. If workers do inhale high concentrations of formaldehyde, coughing, difficulty in breathing and pulmonary edema may occur. Ingestion, although usually not occurring in industrial experience, may cause severe irritation of the mouth, throat, and stomach.

The National Institute for Occupational Safety and Health (NIOSH) recommends that formaldehyde be handled as a potential occupational carcinogen and that appropriate controls be used to reduce worker exposure. These recommendations are based primarily on a Chemical Industry Institute of Toxicology (CIIT) study in which laboratory rats and mice exposed to formaldehyde vapor developed nasal cancer, and are supported by a New York University study where rats exposed to a mixture of formaldehyde and hydrochloric acid vapors developed nasal cancer. Formaldehyde has also been shown to be a mutagen in several short-term laboratory studies.

B. Aldehyde Compounds (⁵)

Aldehyde compounds are strongly irritating to the skin, eyes and respiratory tract. Acute exposure may result in pulmonary injuries such as edema, bronchitis and bronchopneumonia. Skin and pulmonary sensitization may develop in some individuals and result in contact dermatitis and, more rarely, asthmatic attacks.

C. Toluene (⁵)

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

Systemic - 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.

VI. RESULTS AND DISCUSSION

Aldehydes - Many aldehydes were identified in the bulk samples of polyethylene, polypropylene acrylic and polyester plastics, viz. formaldehyde, acetaldehyde, propionaldehyde, n-butyraldehyde and n-valeraldehyde. The two general air samples taken on the oven and on the work desk showed only formaldehyde to be present (0.46-0.90 mg/M³) which is below OSHA standards. All other aldehydes were below the lower limit of detection which was 0.07 mg/samples for propionaldehyde and 0.02 mg/samples for all others.

Organics - The main organic components from the plastic decomposition were benzene, toluene, acetone and some aliphatics (alkanes, olefins) in the C₈-C₁₂ region. Four general air samples were collected on the oven and work desk. Two samples were collected on porous polymer and two on charcoal. In both samples toluene was present (1.94-3.87 mg/M³). These amounts were below NIOSH and OSHA standards. The other compounds were present in very minimal amounts but could not be positively identified due to interference.

The present system of exhausting the ovens is by thermal rise. The present duct has three 90° bends resulting in the cooling of the fumes and ineffective exhausting of the decomposition products. A more desirable method of exhausting would be to have as direct a rise as possible to minimize the cooling of the fumes. Or if this is impossible mechanically forced ventilation should be installed.

VII. RECOMMENDATIONS

Redesign the exhaust ventilation from the baking oven by either elimination of as many as possible 90° bends in the duct or install mechanical ventilation on the duct.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report prepared by:

Walter J. Chrostek
Regional Industrial Hygienist
Project Leader, HETAB, NIOSH

William E. Shoemaker
Regional Program Coordinator
NIOSH, Region III

Originating Office:

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

Report typed by:

Mrs. Mary R. Tomassini
Secretary
NIOSH, Region III
Philadelphia, PA

Acknowledgements

Laboratory Analysis:

Utah Biomedical Test Laboratory
Salt Lake City, UT

NIOSH Measurement Development Section
Cincinnati, Ohio

IX. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Service, Information Resource and Dissemination Section, 4676 Columbia Parkway, Cincinnati, OH 45226. After 90 days, this report will be available through the National Technical Information Service (NTIS), Springfield, VA. Information regarding its availability through NTIS can be obtained from NIOSH, Publication Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Hospital of the University of Pennsylvania, INA Orthotic/Prosthetic Research Laboratory
2. Employee Representative
3. NIOSH, Region III
4. OSHA, Region III

For the purpose of informing the three employees of the results of the 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, Volume I (NIOSH) Publication #77-157A
2. U.S. Department of Labor, Occupational Safety and Health Administration, Federal Register, Volume 39, No. 125, June 27, 1974, (Revised Nov.7, 1978)
3. NIOSH Criteria for a Recommended Standard, Occupational Exposure to Formaldehyde, Publication #77-126, December 1976 (NIOSH)
4. NIOSH Criteria for a Recommended Standard, Occupational Exposure to Toluene, Publication #77-11023, July, 1973, (NIOSH)
5. Occupational Diseases: A Guide to Their Recognition, USPHS, CDC, NIOSH Publication #77-181, Revised June 1977.
6. NIOSH Current Intelligence Bulletin 34, April 15, 1981.

TABLE I
 HETA 81-298
 Hospital of the University of Pennsylvania
 Piersol Rehabilitation Building
 INA Orthotic/Prosthetic Research Laboratory
 Philadelphia, Pennsylvania

May 8, 1981

Results of Work Area Air Sampling for Formaldehyde

| <u>Sample #</u> | <u>Location</u> | <u>Time</u> | <u>Airborne Concentrations*</u> | <u>Remarks</u> |
|-----------------|-----------------|-------------|---------------------------------|-------------------------|
| 5 | Oven | 09:35-11:10 | 0.46 | General Air (Work Area) |
| 6 | Work Bench | 09:35-11:10 | 0.90 | General Air (Work Area) |

TABLE II

Results of Work Area Air Sampling for Toluene

| <u>Sample #</u> | <u>Location</u> | <u>Time</u> | <u>Airborne Concentrations</u> | <u>Remarks</u> |
|-----------------|-----------------|-------------|--------------------------------|----------------|
| 1 | Work Bench | 09:35-14:45 | 1.94 | Charcoal |
| 2 | Oven | 09:35-14:45 | 1.94 | Charcoal |
| 3 | Work Bench | 09:35-14:45 | 3.23 | Porous Polymer |
| 4 | Oven | 09:35-14:45 | 3.87 | Porous Polymer |

Evaluation Criteria*
 (8 hour TWA)

| <u>Substance</u> | <u>OSHA</u> | <u>NIOSH</u> |
|------------------|-------------|---|
| Formaldehyde | 3.6 | **1.2 (for any 30 minute sampling period) |
| Toluene | 750 | 375 |

*Denotes milligram of contaminant per cubic meter of air sampled

**Former NIOSH recommendation based upon irritant effects.