U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health
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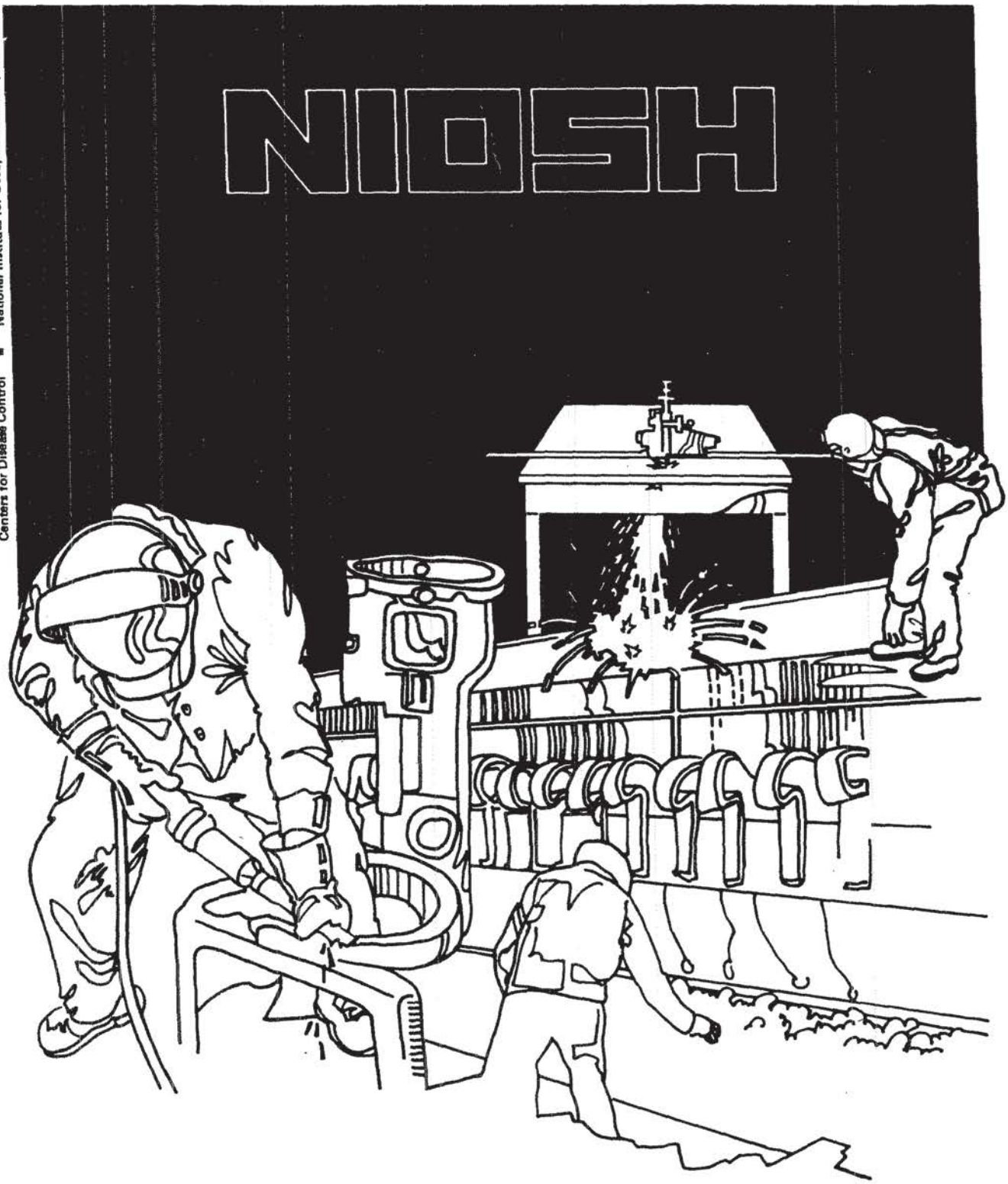

Health Hazard Evaluation Report

HETA 81-403-1024
ROOFING SITE
MIAMI, FLORIDA

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.

HETA 81-403-1024
December 1981
Roofing Site
Miami, Florida

NIOSH Investigator:
Dawn Gilles Tharr, I.H.

I. SUMMARY

On August 4, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Director of Safety and Health, United Union of Roofers, Waterproofers and Allied Workers, for an environmental evaluation of the application of a single ply roofing system. Concern was expressed regarding worker exposure to adhesives and solvents used during the application of approximately 1/16" sheets of polyvinyl chloride (PVC) membrane to the roof and to potential decomposition products from the membrane when the edges are heat sealed.

On August 19-20, 1981, personal breathing zone and process air samples were collected for measurement of exposure to hydrogen chloride (HCl) and carbon monoxide (CO) [the major thermal decomposition products of PVC], and various solvents during the application of a Braas system single-ply roof. Employees were also questioned as to work-related health problems.

A total of 15 personal samples were collected for HCl using silica gel tubes. Detectable levels of HCl were found on only two samples. A concentration of 1.4 ppm of HCl was detected during a 15 minute sampling period when a hand held heat sealer was in use. An HCl concentration of 0.5 ppm was found during a 1-hour sampling period when an automatic sealer was being used. Direct reading detector tube samples taken during the period of the evaluation indicated breathing zone HCl concentrations ranging from non-detectable to 4 ppm. Samples taken directly in the smoke produced during heat sealing indicated levels of HCl greater than 10 ppm (upper limit of quantitation). The OSHA standard for HCl is 5 ppm as a ceiling value (15 minutes).

Detector tube samples were also collected for carbon monoxide (CO) during heat sealing operations. CO levels in the smoke were found to be approximately 5 ppm. Only trace amounts of CO were detected in the workers breathing zone. The standard recommended by NIOSH is 35 ppm with a ceiling value of 200 ppm.

Charcoal tube samples for solvent analyses were collected in the breathing zones of two individuals applying adhesives. Methyl ethyl ketone (MEK) and tetrahydrofuran (THF) were detected on one of the personal samples. Concentrations were 1 ppm and 2 ppm, respectively. The permissible exposure limit for both MEK and THF is 200 ppm. No other solvents were detected.

Workers reported no work related health problems on the days of the study.

Based on the data collected during the study, no health hazards were found in association with the application of the single-ply roofing system under the conditions evaluated. The data does, however, indicate potential for exposure to HCl and under different conditions of application, excessive HCl exposure could occur. Recommendations for improved work practices and controls for potential exposures are made in Section VII of this report.

KEY WORDS: SIC 1761 (Roofing and Sheet Metal Work) PVC membrane, hydrogen chloride, carbon monoxide, methyl ethyl ketone, tetrahydrofuran.

II. INTRODUCTION

In August, 1981 the United Union of Roofers, Waterproofers, and Allied Workers submitted a request to the National Institute for Occupational Safety and Health (NIOSH) to evaluate potential exposures resulting from application of single-ply roofing systems. Many such single-ply systems are presently being used and although methods of application vary, most use a combination of adhesives along with hot air heat sealing. Exposure concerns include decomposition products from the roofing membranes (usually polyvinyl chloride (PVC) or neoprene) and solvents from the adhesives. This study evaluated the application of a single-ply system manufactured by Braas Systems, Inc.

III. BACKGROUND

The application of a single-ply roofing system involves several steps and varies in method between manufacturers. The system evaluated during this study, the Braas System, was applied directly over an old pitch roof. The first step involved the application of a polyester separation layer directly over the old roof. PVC disc sets were then fastened through the separation layer and into the deck at a rate of approximately one per 2.5 square feet. The 6" PVC discs were applied using mechanical fastening screws with metal disc collars. Adhesive was then applied by means of a small paint brush to each disc and the PVC membrane was unrolled over the discs. Each successive membrane which was applied in the same manner overlapped the previously applied membrane by approximately two inches. The seams of adjoining membranes were then welded together using a heat sealer. (The heat sealer was either a hand held gun or a self-propelled automatic sealer.) Additional pieces of membrane were used at roof intrusions and molded to fit using the hand held hot air gun and a small roller.

The roofing crew consisted of six workers. Two workers were laying the separation layer and attaching discs, two workers were applying adhesive and rolling out the membrane and one to two workers were heat sealing.

IV. EVALUATION DESIGN AND METHODS

An environmental survey was conducted on August 19-20, 1981. Personal breathing zone and process samples were collected for hydrogen chloride (HCl) and carbon monoxide (CO) [the major thermal decomposition products of PCV] and for various solvents present in the adhesives.

Samples for HCl were collected on silica gel tubes at a flowrate of 200 cc/minute. Sampling periods varied between 15 minutes and 2 1/2 hours. The samples were analyzed for HCl by ion chromatography according to NIOSH method P&CAM No. 310. Additional samples for HCl were taken using detector tubes.

Detector tubes were used to collect samples for CO during heat sealing operations.

Charcoal tube samples for solvent analyses were collected on the two individuals applying adhesives. Samples were collected at a flow rate of 50 cc/minutes and analyzed by gas chromatography (GC) according to NIOSH method P&CAM 127.

Bulk samples of the adhesive, hardening agent, solvent welding solution and thinner were collected and analyzed by GC and mass spectrophotometry to identify major solvent components. The results were used to specify analytes on the personal samples.

Workers were questioned as to any work related health problems.

V. EVALUATION CRITERIA

The environmental evaluation criteria used in this report as related to airborne exposures to toxic substances are (1) NIOSH recommended standards and/or (2) Federal Occupational Health Standards (as promulgated and enforced by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (29 CFR 1910.1000). Listed below are the evaluation criteria for the sampled substances in this evaluation. Following is a brief discussion pertaining to the primary health effects resulting from exposure to HCl.

	Permissible Exposure Limit (PEL)	
Substance	NIOSH	OSHA
Hydrogen Chloride	-	5 ppm*
Methyl Ethyl Ketone	200 ppm	200 ppm
Tetrahydrofuran	200 ppm	200 ppm
Carbon Monoxide	35 ppm	50 ppm

*Ceiling value - not to be exceeded.

Hydrogen Chloride - Exposure to hydrogen chloride may cause severe irritation of the upper respiratory tract resulting in cough, burning of the throat and a choking sensation; effects are usually limited to inflammation and occasionally ulceration of the nose, throat and larynx. High concentrations also cause eye irritation and skin inflammation.

VI. RESULTS AND DISCUSSION

Analyses of 10 samples for solvents indicated only the presence of MEK and THF. The two solvents were detected on only one sample at 1 ppm and 2 ppm levels, respectively. The permissible exposure level (PEL) for both solvents is 200 ppm.

Carbon monoxide was measured directly in the smoke which resulted during heat sealing at concentrations ranging from non-detected to approximately 5 ppm. Readings, however, taken in the breathing zone of the worker indicated only trace levels of CO. The PEL for CO is 35 ppm.

Of the 15 personal samples collected for HCl only two samples showed detectable levels. A concentration of 0.5 ppm of HCl was detected on a one hour sample taken while using the auto sealer and 1.4 ppm of HCl was detected on a 15 minute sample collected while using the hand held gun. Results of numerous detector tube samples for HCl indicated concentrations in the breathing zone ranging from non-detected to approximately 4 ppm. The PEL for HCl is 5 ppm.

Detector tube samples taken directly in the smoke generated during heat sealing indicated levels of HCl greater than 10 ppm. The HCl detector tubes are designed to be read after 10 strokes with a maximum concentration reading of 10 ppm. When samples were collected in the smoke, 4 strokes on the detector tube resulted in a total color change of the tube. The results, therefore, indicate that the smoke contained considerably more than 10 ppm of HCl. The results of the personal samples, however, indicate very little exposure to HCl occurred. It is believed that personal exposures were not higher for two reasons: (1) The roofing was being conducted on a flat, single story building which was higher than most of its surroundings. The wind speed during the two day survey ranged from 150 feet per minute (fpm) to greater than 600 fpm. With nothing to obstruct the air movement, most of the smoke and thus the HCl was carried away before reaching the breathing zone of the workers; and (2) Heat sealing was an intermittent and relatively nonstationary job during the two days of sampling. Hence, even in the absence of considerable air movement, a buildup of contaminants probably would not have occurred.

The above data indicates that a potential for excessive exposure to HCl does exist if the conditions under which a single-ply roof is applied differ from those evaluated during this study. A worker heat sealing PVC in a confined area, such as near a high wall, under a air handling unit, etc., could be overexposed to HCl. Such overexposures have been reported, with HCl concentrations ranging from 17 ppm to 60 ppm.[3] It should be noted, however, based on the findings of this study it is unlikely that overexposure to CO or solvents would occur unless very extreme conditions existed.

VII. RECOMMENDATIONS

Based on the potential for exposure and previously documented overexposure to HCl the following recommendations are being made:

1. Approved respiratory protection should be provided to workers involved with heat sealing procedures to protect against excessive exposure to HCl. Respiratory protection should be worn whenever a question of adequate ventilation exists or when working in confined areas. A respiratory protection program should be established and maintained in accordance with 29 CFR 1910.134.

2. Workers should be educated as to the potential exposures associated with heat sealing PVC materials and the resulting health effects and symptoms.

VIII. REFERENCES

1. Vandervort R, Brooks S: Polyvinyl Chloride Film Decomposition Products as an Occupational Illness. J of Occ Med. Vol. 19, No. 3.

2. Wooley WD. A Study and Toxic Evaluation of the Products From the Thermal Decomposition of PVC in Air and Nitrogen. Fire Research Station, July 1969.

3. Personal communication with OSHA offices in Fort Lauderdale, Florida and Cincinnati, Ohio.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standard 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), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of the report have been sent to:

1. Director of Safety and Health, United Union of Roofers, Waterproofers and Allied Workers, Washington, D.C.
2. Ecco Systems Roofing, Ft. Lauderdale, Florida
3. OSHA, Region IV
4. NIOSH, Region IV

For purposes of informing the affected employees, a copy of this report shall be posted in a prominent place, accessible to the employees, for a period of thirty (30) calendar days.

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