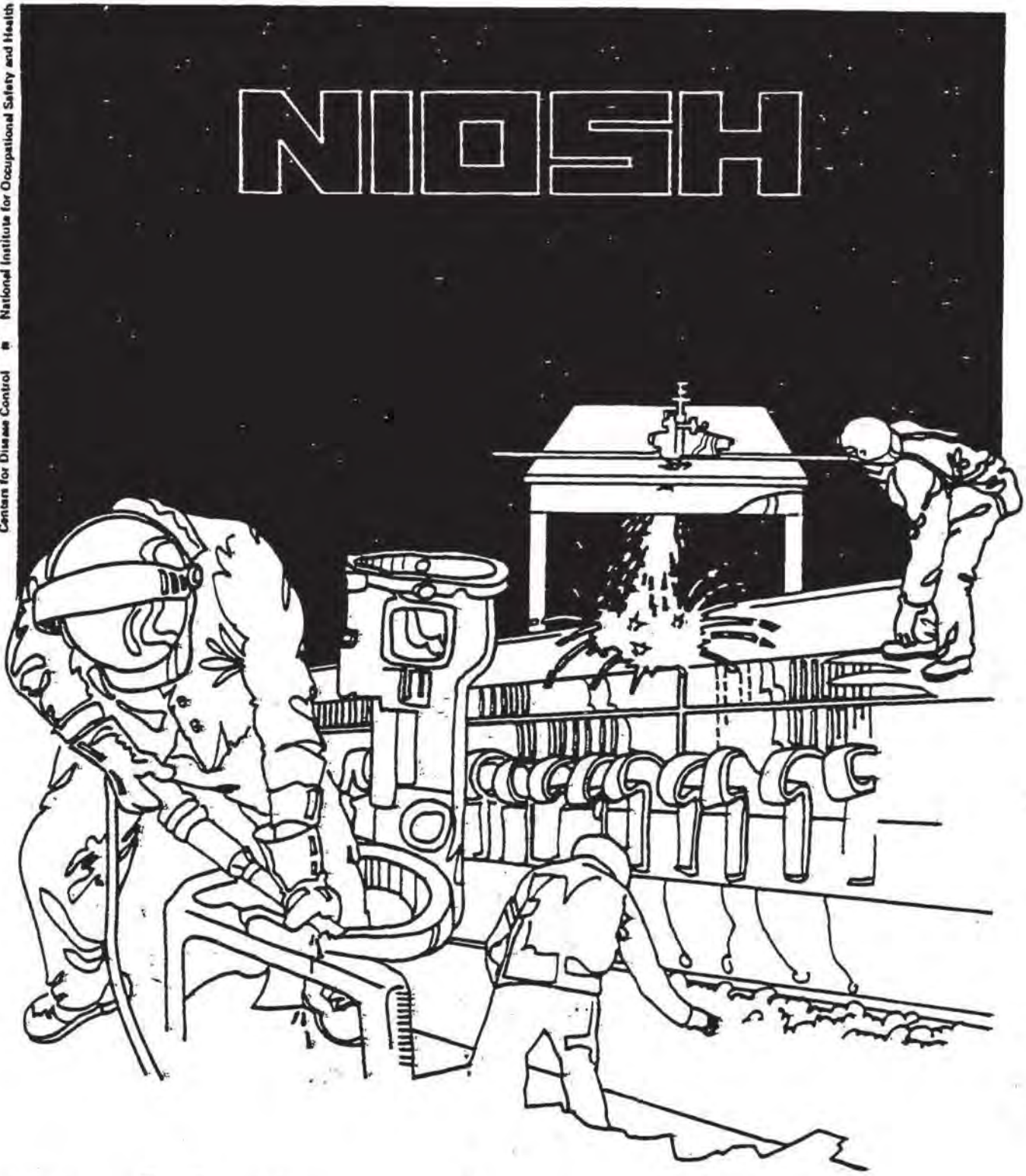
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 81-432-1105
ROOFING SITES
ROCHESTER AND BUFFALO, 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 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.

MAY 1982
ROOFING SITES
ROCHESTER AND BUFFALO, NEW YORK

I. SUMMARY

On August 12, 1981, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Director of Safety and Health, United Union of Roofers, Waterproofers and Allied Workers, to evaluate the tear-off operation of old coal tar pitch roofs and the application of a single-ply roofing system. Concern was expressed over worker exposure to coal tar pitch dust during tear-off operations and to solvent based adhesives used during the application of the single-ply roof.

On October 12-14, 1981, NIOSH collected personal breathing zone air samples to measure roofing worker exposures to total dust, respirable dust, cyclohexane solubles, and polynuclear aromatic hydrocarbons (PNAs) during tear-off operations, handling of hot asphalt and application of hot coal tar pitch. Personal breathing zone air samples were also collected for solvents present in the adhesives which were used during the application of a Carlisle single-ply roof.

Total dust exposures measured during tear-off procedures ranged from 1.8 milligrams per cubic meter (mg/M^3) to 6.2 mg/M^3 [Permissible Exposure Limit (PEL) - 10 mg/M^3], with respirable dust levels ranging from 0.67 mg/M^3 to 1.7 mg/M^3 (PEL - 5 mg/M^3). Exposure to the cyclohexane soluble fraction of the dusts during tear-off ranged from non-detected (N.D.) to 0.51 mg/M^3. Identifiable PNAs in the tear-off dust were fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene. Concentrations of PNAs in the air samples ranged from N.D. to 26 micrograms per cubic meter (ug/M^3). Employees working with hot asphalt had exposure to cyclohexane solubles ranging from 0.16 mg/M^3 to 0.28 mg/M^3 and PNA concentrations ranging from N.D. to 0.9 ug/M^3. The individual working with hot coal tar pitch had an exposure to cyclohexane solubles of 0.11 mg/M^3 and to PNAs ranging from 0.65 ug/M^3 to 17 ug/M^3. NIOSH recommends that employees not be exposed to coal tar pitch in concentrations greater than 0.1 mg/M^3 measured as the cyclohexane soluble fraction. NIOSH considers coal tar pitch a carcinogen and this environmental limit should be regarded as the upper limit of exposure and conditions should be made to keep exposure as low as possible.

Workers reported experiencing phototoxic effects including skin erythema, photophobia and conjunctivitis.

Although limited sampling was conducted during this study, it is interesting to note that the results suggest exposure to cyclohexane solubles and PNAs during tear-off procedures are as high or greater than levels to which workers are exposed during application of new roofs using hot asphalt or pitch.

The eight personal breathing zone air samples collected on the workers applying adhesives were analyzed for acetone, toluene, xylene and hexane. All concentrations were found to be less than 13% of their respective criteria or standards. It was noted, however, that workers had repeated skin contact with the adhesives.

Based on the data collected during this study, workers are exposed to excessive levels of coal tar pitch dust. Workers were not found to be overexposed to solvent vapors, although excessive skin contact was observed. Recommendations for improving work practices and controls for exposure to pitch dust are made in Section VIII of this report.

KEYWORDS: SIC 1761 (Roofing and Sheet Metal Work); coal tar pitch, PNAs, cyclohexane solubles, acetone, toluene, xylene, hexane.

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 the tear-off of old coal tar pitch roofs and also exposures related to the application of a single-ply roofing system. During the study, two coal tar pitch tear-off operations, one in Rochester, New York and one in Buffalo, New York were evaluated. At the Rochester location workers were also using hot asphalt to reapply insulation to the roof surface after the tear-off and in Buffalo, workers were applying a new coal tar pitch roof after the tear-off. These situations provided an opportunity to do some comparisons of tear-off exposures versus application exposures under the same work and weather conditions. At the Rochester location, exposure to solvents present in the adhesives used to apply the Carlisle single-ply roofing system were also evaluated.

A letter containing preliminary findings was distributed in December, 1981.

III. BACKGROUND

A. Rochester, New York

The study conducted in Rochester, New York evaluated the removal or tear-off of an old coal tar pitch roof and the application of a new Carlisle single-ply roof.

The tear-off operation was started by using a power broom to sweep the loose gravel from the roof. A power cutter was then used to break up the pitch layer down to the insulation. The old roof was then pried and scraped from the surface and transported to the edge of the building for discarding. The power broom was again used to remove additional smaller debris from the roof surface. Following completion of the tear-off, the roof surface was mopped with hot asphalt, over which approximately 3 foot squares of 1 1/2" thick rigid insulation were placed. The roof surface was then ready for the application of the single-ply material.

The application of the single-ply roofing systems involved several steps, the first of which was to unroll a sheet of neoprene membrane over the insulation and fold it over in half lengthwise, exposing the insulation underneath. Adhesive was then applied to the insulation and the exposed side of the membrane using a semi-automatic applier which was hand pulled by a worker. Following the application of the adhesive using the applier, workers used paint rollers with 6 foot handles to complete the even application of the adhesive on the two surfaces. The adhesive was allowed to dry until it was tacky to the touch. The workers then slowly pushed the folded side of the membrane over the adhesive covered insulation. With one side of the membrane secured, the process was repeated on the remaining half. Each successive membrane which was applied in the same manner, overlapped the previously applied membrane by approximately 3 inches. The edges of the adjacent membranes were then cleaned using a rag soaked with unleaded gasoline and the edges were sealed together by a splicing cement. The open side of the splice then received a bead of lap sealant applied with a caulking gun. The bead was worked smooth with a flat blade.

There were approximately 8 individuals involved in the tear-off and application work. Most individuals rotate freely from one job to another as needed.

B. Buffalo, New York

The tear-off operation in Buffalo also involved the removal of an old coal tar pitch roof. First, all the loose gravel was collected and removed from the roof surface. A power cutter was then used to break up the pitch layer down to the insulation. This process was followed by a power plow which loosened the pitch from the insulation so workers could remove the large scrap pieces and discard them over the edge of the building. After removal of the large pieces of old pitch, a power blower was used to remove all dust and small pieces of debris from the roof surface. To help keep dust levels down, the roof was hosed down with water during the tear-off. Approximately six workers were involved in the tear-off process.

IV. EVALUATION DESIGN AND METHODS

Environmental sampling was conducted at the two roofing sites on October 12-14, 1981. Personal breathing zone air samples for total particulates were collected on preweighed M-5 filters at a flowrate of 1.5 liters per minute (lpm). Respirable particulate samples were collected on M-5 filters using 10 mm cyclones at a flowrate of 1.7 lpm. All filters were analyzed gravimetrically.

Personal breathing zone air samples for determination of cyclohexane solubles and PNAs were taken on glass fiber/silver membrane filters at a flowrate of I.5 lpm. Samples were analyzed for cyclohexane solubles according to NIOSH Method P&CAM 217. The PNAs were analyzed by liquid chromatography.

A bulk sample of the tear-off dust was analyzed to identify which individual PNAs were present. This information was used to specify analytes on the personal samples.

Personal breathing zone air samples for acetone, toluene, xylene and hexane were collected on the workers applying adhesives. Samples were collected on charcoal tubes at flowrates between 50-200 cc/minute and analyzed by gas chromatography according to NIOSH Method P&CAM 127.

Bulk samples of the various adhesives were collected and analyzed by gas chromatography/mass spectrophotometry to identify major solvent components. The results were used to specify analytes on the personal samples.

V. EVALUATION CRITERIA

The environmental evaluation criteria used in this report as related to airborne exposures to toxic substances are (1) NIOSH recommended standards (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), and/or (3) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's). Listed below are the evaluation criteria for the sampled substances in this evaluation. The following is a discussion pertaining to the primary health effects resulting from exposure to coal tar pitch and suggested exposure limits.

Substance	Permissible Exposure Level	Source	OSHA Standard
Acetone	750 ppm	ACGIH	1000 ppm
Toluene	100 ppm	NIOSH	200 ppm
Xylene	100 ppm	NIOSH	100 ppm
Hexane	100 ppm	NIOSH	500 ppm
Respirable Nuisance Dust	5 mg/M^3	ACGIH	10 mg/M^3
Total Nuisance Dust	10 mg/M^3	ACGIH	15 mg/M^3

Coal Tar Products The term "coal tar product" as used in the NIOSH recommended standard, includes coal tar, coal tar pitch and creosote. Exposure to coal tar products has been reported to produce phototoxic effects, such as skin erythema, burning and itching of the skin, photophobia and conjunctivitis. From the epidemiologic and experimental toxicologic evidence on coal tar products, NIOSH has concluded that they are carcinogenic and can increase the risk of lung and skin cancer in workers. Coal tar products often contain identifiable components which by themselves are carcinogenic such as benzo(a)pyrene, benzanthracene and chrysene.

NIOSH recommends that occupational exposure to coal tar product be controlled so that workers are not exposed to coal tar, coal tar pitch, creosote, or mixtures of these substances at concentrations greater than 0.1 mg/M^3 of the cyclohexane - extractable fraction of the sample as a time-weighted average (TWA) concentration for up to a 10 hour shift in a 40-hour workweek. This limit was recommended because it was the lowest concentration that could be reliably detected by the recommended method of environmental monitoring. While compliance with the limit should reduce the incidence of cancer, no absolute safe concentration can be established for a carcinogen at this time. Therefore the recommended limit should be regarded as an upper limit of exposure and every effort should be made to keep exposures as low as is technically feasible.

Evidence indicates that the same recommended level or a lower level should apply to coal tar pitch tear-off dust produced during the removal of old coal tar pitch roofing material. Data collected to date indicates that the pitch tear-off dust produces similar acute health effects as exposure to other coal tar products. This was evident in the results reported by Hervin and Emmett in 1976[1] where exposure to pitch dust resulting from a tear-off operation was associated with severe symptoms of photosensitivity. There is also evidence to suggest that the carcinogenic potential of the coal tar products and pitch dust are similar. A report published in the Journal of Industrial Medicine (1981), "A Carcinogenic Bioassay of Certain Roofing Materials"[3] reported on a study designed to evaluate the carcinogenic potential on mouse skin of materials to which present day roofers are exposed, including traditional coal tar pitch, coal tar bitumen, standard asphalt and dust produced during the removal of an old coal tar pitch containing roof. The results of the study demonstrated that tear-off pitch dust is strongly carcinogenic to mouse skin and under the circumstances of the experiment was associated with the shortest latent period to cancer observed in any group. There was also no statistically significant difference between the carcinogenicity of the tear-off dust and the coal tar pitch from which it was presumably derived.

VI. RESULTS AND DISCUSSION

A total of five total dust samples were collected to determine total particulate exposure during tear-off operations. Total dust concentrations ranged from 1.8 mg/M^3 to 6.2 mg/M^3. Two dust samples showed respirable dust levels of 0.67 mg/M^3 and 1.7 mg/M^3 (Tables 1-2).

Exposure to cyclohexane solubles during tear-off procedures were found to range from N.D. to 0.51 mg/M^3. No cyclohexane solubles were found in the respirable samples. PNAs which were identified in a bulk sample of the tear-off dust were fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene. Concentrations of these PNAs found in the personal air samples ranged from N.D. to 26 ug/M^3. For comparison purposes the levels of cyclohexane solubles and PNAs were also measured on employees working with hot asphalt and one individual applying hot coal tar pitch. Employees working with hot asphalt had exposures to cyclohexane solubles ranging from 0.16 mg/M^3 to 0.28 mg/M^3 and PNA concentrations ranging from N.D. to 0.9 ug/M^3. The worker operating the felt machine using hot coal tar pitch had an exposure to cyclohexane solubles of 0.11 mg/M^3 and to PNA's ranging from 0.65 ug/M^3 to 17 ug/M^3. NIOSH recommends that workers not be exposed to cyclohexane solubles greater than 0.1 mg/M^3. Although sampling periods were less than 8 hours, workers typically performed the sampled task for 4-8 hours per day. Based on this information, considering the sampled time as representative of complete task exposures, workers exposures would still exceed the recommended 0.1 mg/M^3 level on an 8 hour basis. In addition workers were documented as being exposed to levels of known carcinogens, PNAs, for which no safe level of exposure is known.

Although limited sampling was conducted during this evaluation, the results indicate that workers exposed to tear-off dust are exposed to higher concentrations of cyclohexane solubles and PNAs than workers involved with application of hot asphalt or coal tar pitch. This data is also supported by the findings of Hervin and Emmett in 1976[1,2] where the same relative exposure levels for cyclohexane solubles were documented for tear-off and application processes.

Informal interviews with workers also indicated that they experience the same type of symptoms during tear-offs as they do with application of hot coal tar pitch. Workers reported phototoxic effects including skin erythema, photophobia and conjunctivitis. Symptoms are usually experienced only during tear-offs of coal tar pitch roofs. Similar problems are not experienced with asphalt roofs. (Asphalt exposures are usually associated with higher cyclohexane soluble exposures but lower or non-detectable PNA exposures). Again a similar pattern of symptoms was reported and documented by the Hervin & Emmett studies.

These findings are of particular interest and concern for four reasons: (1) the reported and documented acute health effects of skin erythema, photophobia and conjunctivitis (2) the recent data on the carcinogenic potential of tear-off dust (3) the relatively high exposure levels measures and (4) the relative lack of concern of workers associated with exposure to tear-off dusts.

Results of the analyses for solvents contained in the adhesives used to apply the single-ply roofing system are presented in Table 3. A review of the data will indicate that workers were exposed to relatively low airborne solvent concentrations. Acetone concentrations ranged from non-detected (N.D.) to 13.5 ppm [permissible exposure level (PEL - 750 ppm)], toluene concentrations ranged from N.D. to 5.9 ppm (PEL - 100 ppm), xylene concentrations ranged from N.D. to 0.2 ppm (PEL - 100 ppm) and hexane concentrations ranged from 1.3 ppm to 13 ppm (PEL - 100 ppm). These findings are consistent with other study results on single-ply roofing applications.[4,5] It should be noted, however, that workers also had skin contact with the adhesives. Repeated or prolonged skin contact with any of these materials may cause drying and defatting of the skin which may lead to dermatitis. In addition, xylene and toluene enter the body both by inhalation of vapor and percutaneous absorption of the liquid. Therefore to avoid potential adverse health effects, workers should avoid exposure as a result of both inhalation and skin contact.

VII. CONCLUSIONS

The data collected during this study and supported by past evaluations indicate that workers are exposed to excessive levels of coal tar pitch dust during tear-off operations. Exposures do result in acute health effects, photosensitization, and have a potential for long term carcinogenic effects.

Workers were not found to be overexposed to solvent vapors during application of the single-ply system, although excessive skin contact was observed.

VIII. RECOMMENDATIONS

1. Water should be used to thoroughly wet and dampen the surface of the roof prior to and during tear-off operations.

2. The use of power brooms and power blowers to remove small debris and dust should be replaced with a vacuum system to reduce dust levels.

3. Workers should stay upwind of pitch dust whenever possible.

4. Workers should wear safety goggles to prevent coal tar pitch dust exposure to the eyes and to protect workers from eye injury from flying debris during cutting operations.

5. Workers should shower and wash thoroughly with soap and water at the end of each work shift. Clean work clothes should be worn daily. Clothing contaminated with coal tar pitch dust should not be laundered at home with other family clothing.

6. Highly exposed individuals should wear respiratory protection. Due to the effects on eyes, skin and the respiratory tract, along with the high temperatures encountered during the summer months, protection and comfort may best be provided by using powered air-purifying helmet respirators. Respirators should be selected, used and maintained in accordance with OSHA regulations (29 CFR 1910.134).

7. Workers who experience skin photosensitivity should try using a sunscreen which blocks out ultraviolet light, such as Uval Sunscreen Location (sulisobenzone, 10%) applied 1/4 - 1/2 hour before the shift starts.

8. Workers should avoid skin contact with gasoline, solvents or solvent based adhesives. Gloves, impervious to the solvents, should be worn when handling any of these materials where skin contact is likely to occur.

9. Adhesives should be removed from the skin using a waterless cleaner rather than solvents or gasoline.

10. Workers should not smoke around flammable solvents, adhesives or gasoline.

IX. REFERENCES

1. Hervin, R.L. and Emmett, E.A. "Health Hazard Evaluation Determination Report No. 75-194-324." National Institute for Occupational Safety and Health, Cincinnati, Ohio (1976).

2. Hervin, R.L. and Emmett, E.A. "Health Hazard Evaluation Determination Report No. 75-102-304." National Institute for Occupational Safety and Health, Cincinnati, Ohio (1976).

3. Emmett, E.A., Bingham, E. and Barkley, W. "A Carcinogenic Bioassay of Certain Roofing Materials, "American Journal of Industrial Medicine 2:59-64 (1981).

4. Tharr, D.G. "Health Hazard Evaluation Determination Report No. 81-403-1024." National Institute for Occupational Safety and Health, Cincinnati, Ohio (1982).

5. Albrecht, W.N. "Health Hazard Evaluation Determination Report No. 81-468-1036." National Institute for Occupational Safety and Health, Cincinnati, Ohio (1982).

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Dawn Gilles Tharr
Industrial Hygienist
Industrial Hygiene Section

Environmental Assistance:

Laurence Reed
Industrial Hygienist
Industrial Hygiene Section

Originating Office:

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

Report Typed By:

Jackie Woodruff
Clerk/Typist
Industrial Hygiene Section

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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, Springfield, Virginia 22161. 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. United Union of Roofers, Waterproofers and Allied Workers, Washington, D.C.
2. NIOSH, Region II
3. OSHA, Region II

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 1

ROOFING SITE
ROCHESTER, NEW YORK

HETA 81-432

Total Dust Exposures

Date	Job	Sampling Period	Total Particulate (mg/M^3)
10/13/81	Cutter	7:10-10:13	2.6
10/13/81	Pitch Removal	8:15-9:50	6.2

Cyclohexane Soluble and Polynuclear Aromatic Hydrocarbon (PNA) Levels

Date	Job	Sampling Period	Cyclohexane Solubles (mg/M^3)	Fluoranthene (ug/M^3)	Pyrene (ug/M^3)	B(a)A (ug/M^3)	Chrysene (ug/M^3)	B(a)P (ug/M^3)
10/13/81	Cutter	7:10-10:13	0.51	26	18	14	9	11
10/13/81	Pitch Removal	8:15-9:50	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
10/13/81	Mopping Asphalt	1:24-2:47	0.16	N6	0.73	N.D.	N.D.	N.D.
10/13/81	Kettle Operator	1:27-3:02	0.28	0.85	1.1	0.7	0.63	0.63
10/12/81	Mopping Asphalt	1:50-4:26	0.17	0.7	0.9	0.38	N.D.	N.D.
10/12/81	Laying Insulation	1:56-4:25	0.18	0.36	0.4	0.27	N.D.	N.D.

TABLE 2

ROOFING SITE
BUFFALO, NEW YORK
HETA 81-432

October 14, 1981

Total Dust Levels

Job	Sampling Period	Total Particulates (mg/M^3)
Cutter	1:15-2:00	3.6 mg/M^3
Pitch Removal	2:30-3:30	1.8 mg/M^3
Laying Insulation	2:07-3:39	3.9 mg/M^3

Respirable Dust Levels

Job	Sampling Period	Respirable Dust (mg/M^3)
Power Plow	1:20-3:30	0.67
Pitch Removal	1:28-2:00	1.7

Cyclohexane Soluble and Polynuclear Aromatic Hydrocarbon Levels

Job	Sampling Period	Cyclohexane Solubles (mg/M^3)	Fluoranthene (ug/M^3)	Pyrene (ug/M^3)	B(a)A (ug/M^3)	Chrysene (ug/M^3)	B(a)P ug/M^3)
Respirable Fraction							
Cutter	1:15-2:00	N.D.	1.1	N.D.	0.66	N.D.	N.D.
Pitch Removal	1:30-2:00	N.D.	N.D.	1.8	N.D.	N.D.	N.D.
Total							
Power Plow Operator	1:20-3:30	0.21	2.0	1.8	1.2	1.1	1.2
Pitch Removal	1:28-3:30	N.D.	0.71	0.82	0.44	N.D.	0.38
Felt Machine Operator	2:05-4:09	0.11	17	11	2.6	2.5	0.65

TABLE 3

RESULTS OF PERSONAL AIR SAMPLES FOR ORGANIC SOLVENTS

ROOFING SITE
ROCHESTER, NEW YORK
HETA 81-432

October 12-13, 1981

Job	Sampling Period	Acetone (ppm)	Toluene (ppm)	Xylene (ppm)	Hexane (ppm)
Applying adhesive with roller (Worker A)	14;30-16;30	N.D.	5.2	N.D.	1.8
Applying adhesive with roller (Worker B)	14;30-16:30	1.0	5.9	N.D.	2.3
Applying adhesive using auto applier	9;50-16:45	2.3	5.2	0.1	3.3
Smoothing applied adhesive with roller	9;55-11:50	0.8	3.4	N.D.	1.3
Smoothing applied adhesive with roller	10;00-11;50	2.5	4.7	N.D.	2.2
Applying splicing cement	11;10-11;45	13.5	13	N.D.	13
Applying adhesive and lap sealant	13;30-16;45	1.4	4.3	0.2	2.1
Applying adhesive and lap sealant	13;55-14;40	N.D.	4.0	N.D.	1.4
Permissible Exposure Levels		750	100	100	100

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396