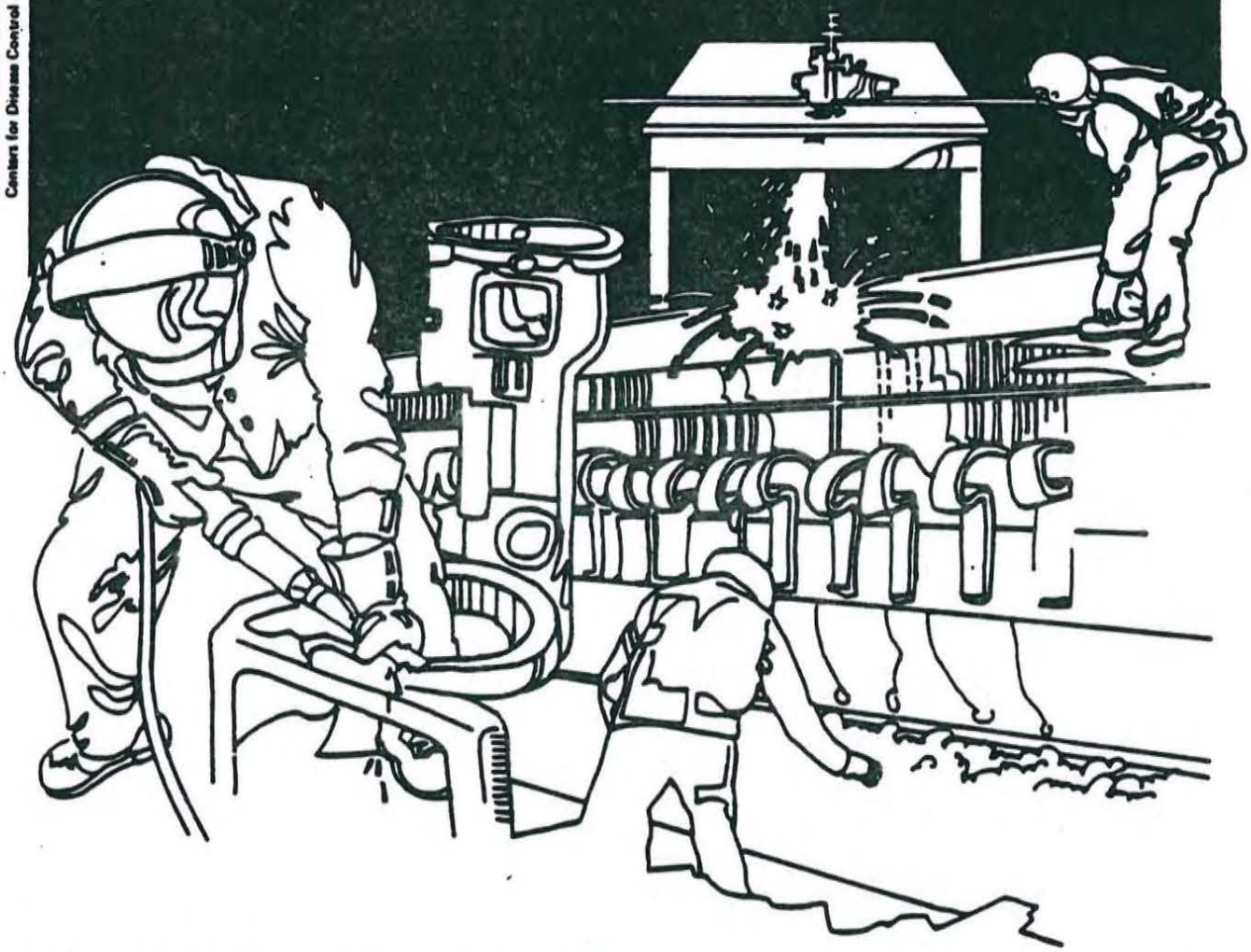
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 83-198-1646
U.S. ARMY CORPS
OF ENGINEERS SUPPLY DEPOT
KANSAS CITY, MISSOURI

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 83-198-1646
January 1986
U.S. ARMY CORPS OF ENGINEERS SUPPLY DEPOT
KANSAS CITY, MISSOURI

NIOSH INVESTIGATOR:
George A. Carson, Ph.D., CIH

I. SUMMARY

In March 1983, the National Institute for Occupational Safety and Health (NIOSH) was requested by the U.S. Army Corps of Engineers (COE), Kansas City District, to evaluate working conditions and provide recommendations to reduce occupational exposures during a re-roofing operation at the COE Kansas City Supply Depot. NIOSH representatives conducted environmental surveys at the site on March 28 and April 18 and 19, 1983. Seven workers were involved with the tear off, repair of roof deck, and the application of an asphalt built-up roof covering approximately 3800 feet^2.

Nineteen breathing zone samples were collected, using Zefluor 2-micron filters in opaque 37 millimeter cassettes, followed by ORBO #43 solid sorbent tubes. Seven area air samples were collected, using the same sampling train. Selected filters and the solid sorbents from the area samples were analyzed for selected PNA's.

Acetonitrile solubles for the personal air samples ranged from .04 to .83 mg/m^3 (NIOSH Recommended Standard 5 mg/m^3) over the three-day sampling period for all workers. Area air samples showed non-detectable quantities of the following PNA's: fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(e)pyrene, and benzo(a)pyrene.

Based on the data collected during this operation, it is concluded that workers were not over-exposed to asphalt fumes. However, recommendations are included to further reduce exposures at other sites when coal tar materials may be used in place of asphalt.

KEYWORDS: SIC 1761 (Roofing and Sheet Metal Work); asphalt, PNA's, acetronitrile solubles

II. INTRODUCTION

On March 21, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a letter from the U.S. Army Corps of Engineers (COE), Kansas City District, requesting assistance in evaluating working conditions during re-roofing operations at the Kansas City Supply Depot, 14 East Front Street. At a previous job site, the COE crew had experienced severe eye irritation from the roofing materials being utilized; therefore, they wanted to document concentrations of roofing materials at the new work site.

On March 28 and April 18-19, 1983, the NIOSH investigator gathered information and conducted environmental surveys at the site. Site visits on three different days were necessary because of changing weather conditions and rescheduling of workers by COE management.

III. BACKGROUND

The U.S. Army Corps of Engineers Supply Depot is housed in an older building adjacent to the Missouri River. It is a long, narrow building with a peaked roof and a loading dock all along the south side. This loading dock is covered with a steel-framed and wooden-decked suspended canopy approximately 12 ft. wide, totaling approximately 38 squares (1 square = 100 $ft.^2$). This canopy slants inward and is covered by a built-up coal tar roof, with several penetrations for drains located adjacent to the main structure. The canopy is also pitched toward the drains along the main structure to aid in the removal of rainwater.

IV. PROCESS DESCRIPTION

The old built-up coal tar roof was removed by hand, using spudding bars, shovels, etc. A considerable amount of the roof decking was rotted and had to be replaced prior to beginning the layup of the new roof. ASTM Type III, "steep", asphalt was used as the cementing material. It was received in metal containers that were split open and the material placed in a 300-gallon propane fired kettle for liquefaction. The material was heated to approximately 450°F before delivery to the roof by a mechanical pump. The asphalt material ("hot") was stored in a hot lugger at roof level until it was needed. The hot lugger was wheeled to the point of application on the roof, and the hot was dispensed into mopping buckets. The hot was mopped onto the roof deck or onto previous plys of rolled felt until the desired thickness was obtained. A final flood coat was applied, and then the roof was gravelled to produce the finished top surface.

V. METHODS

Personal air samples for acetonitrile solubles were collected on all seven workers during the three days the survey took place. The acetonitrile soluble portion of the filters was used as the indicator of exposure to asphalt fumes. These air samples were collected using a sampling train that consisted of a Zefluor 2-micron filter (Membrane Company) and a cellulose acetate o-ring in an opaque 37mm cassette, followed by a 7mm O.D. glass tube containing two sections (100 mg/50 mg) pre-washed XAD-2 (ORBO #43). A volumetric flow rate of approximately 2 liters per minute was used to collect workshift samples. The sample flow rates were set in the a.m. and checked and recorded at lunch break and at the end of the shift. These samples were analyzed using NIOSH Method P&CAM 217[1] with modifications. The filters were placed in screw-cap vials with 8 ml of acetronitrile and were then sonified for 45 minutes. The extract was filtered through a 0.45 micron nylon filter and collected in an evaporation tube. Each sample was extracted one additional time with 2 ml of acetonitrile and filtered into the same evaporation tube. The extract was concentrated to 1 ml under a stream of dried nitrogen at 40°C. One-half milliliter of each sample was transferred into a tared Teflon cup and evaporated to dryness in a vacuum oven at 40°C. The Teflon cups were again weighed and the difference recorded, the weight gain of the cup being one-half the total acetonitrile solubles per sample. The limit of detection for this technique was 0.02 mg/sample.

Area air samples for acetonitrile solubles were collected from various locations at the worksite to supplement the personal samples, as well as to provide information to make definitive recommendations. The filters from these samples were handled the same as the personal samples previously discussed.

A limited number of the area air samples were selected for individual polynuclear aromatic hydrocarbon (PNA) analysis using NIOSH Method #5506[2]. The filters were extracted with acetonitrile and the extract analyzed by high performance liquid chromatography for the following PNA's: fluoranthene, pyrene, benz(o)anthracene, chrysene, benzo(e)pyrene, and benzo(a)pyrene. The solid sorbent backup tubes were extracted and analyzed in a similar way for only the first four PNA's listed above.

Bulk solid samples of the asphalt were collected under various conditions during the roofing operation in an attempt to ascertain changes in the PNA composition over time and temperature.

VI. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes and, thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

NIOSH[3] and ACGIH[4] recommend a time-weighted average (TWA) exposure limit of 5.0 mg/m^3 for asphalt fumes. OSHA does not have a personal exposure limit (PEL) for asphalt fumes.

The principal adverse effects on health from exposure to asphalt fumes are irritation of the serous membranes of the conjunctivae and the mucous membranes of the respiratory tract. Hot asphalt can cause burns of the skin. In animals, there is evidence that asphalt left on the skin for long periods of time may result in local carcinomas, but there have been no reports of such effects on human skin that can be attributed to asphalt alone. No reliable reports of malignant tumors of parenchymatous organs due to exposure to asphalt fumes have been found, but there has been no extensive study of this possible consequence of occupational exposure in the asphalt industry.

Asphalt fumes are defined as the cloud of small particles created by condensation from the gaseous state after volatilization of asphalt. Approximately 96% of the asphalt used in this country is used in paving and roofing operations. "Occupational exposure" to asphalt fumes is defined as exposure in the workplace at a concentration of one-half or more of the recommended occupational exposure limit. If exposure to other chemicals also occurs, as is the case when asphalt is mixed with a solvent, emulsified, or used concurrently with other materials such as coal tar or pitch, provisions of any applicable standard for the other chemicals shall also be followed.

VII. RESULTS

The personal air sample acetonitrile soluble results are shown in TABLE I. The 19 samples ranged from .04 to 2.7 mg/m^3 over the three-day sampling period. Based on all the other samples, it is reasonable to assume that the 2.7 mg/m^3 value was not valid. Although there was no direct evidence, it appears that the sample was either tampered with or was contaminated before it reached the laboratory. Therefore, only 18 of the personal samples ranging from .04 to .83 mg/m^3 will be used in the analysis and discussion. None of these samples exceeded the NIOSH recommended criteria of 5.0 mg/m^3.

The area air sample acetonitrile soluble results are shown in TABLE II. The seven samples ranged from .02 to 3.0 mg/m^3, with six of the values less than or equal to .40 mg/m^3. The high value of 3.0 mg/m^3 was obtained directly adjacent to the kettle.

The ten filters submitted for the determination of six PNA's were all reported back at less than the limit of detection which was 250 ng/sample. The ten sorbent tubes that served as the backup to these area samples were submitted for four PNA's analysis. All of these samples were less than the 250 ng/sample limit of detection. Most of these samples had collected material from approximately 0.5 cubic meters of air. Therefore, the air concentrations of the various PNA's would be less than 0.5 ugm/m^3.

No definitive information was generated from the six bulk samples submitted for PNA analysis. The high limits of detection were caused by the insolubility of the samples in acetonitrile.

VIII. DISCUSSION

The samples were collected during three days of this project which was in process over about a month's time. The crew that was doing the work also does other maintenance and repair jobs and does not work at roofing 100% of the time. This was evident during the time span of the data collection in that they would be sent to other jobs and sampling would have to be rescheduled. During the first day of sampling, March 28, 1983, some of the crew was still removing old roofing and repairing the roof deck while others were applying the new roof. During this day, the kettleman was exposed to 0.61 mg/m^3 for the total shift, less one-half hour for lunch; and the remaining crew's average exposure was 0.17 mg/m^3. The temperature was in the mid-40's, under partly cloudy skies, with a slight breeze. Area concentrations at roof level directly above the kettle were .15 mg/m^3 and .06 mg/m^3 away from the kettle.

By April 18, 1983, all of the tearing off was completed and most of the crew was involved with handling the roofing materials. However, there was not any hot on the roof until after 10:00 a.m., and the kettle ran out of fuel at 12:15 p.m. The kettleman's exposure was only .04 mg/m^3 for the shift, and the crew's exposure averaged only .07 mg/m^3. The temperature reached 55°F during the day, under partly cloudy skies, with light breezes. Area samples on the roof showed .02 mg/m^3 above the kettle and .03 mg/m^3 away from the kettle.

The last day of the sampling, April 19, 1983, was the most productive day from the standpoint of completed roof. The kettleman's exposure was .83 mg/m^3 for the shift; the crew's exposure averaged .31 mg/m^3. The temperature rose to 50°F, under partly sunny skies, with very little breeze. Area samples on the roof showed .40 mg/m^3 above the kettle and .13 mg/m^3 away from the kettle. An area sample of 3.0 mg/m^3 was collected directly adjacent to the kettle, which was a good indicator of the amount of material handled on this day.

IX. CONCLUSIONS AND RECOMMENDATIONS

Based on the information and data collected, it has been concluded that no worker was over-exposed to asphalt fumes during the three-day sampling period; therefore, no health hazard from asphalt fumes exists. However, because of the various types of repair and maintenance activities the COE crews are involved in, the above conclusion cannot be made in general to all activities involved with the use of roofing-type materials. For instance, if coal tar products had been used as the mastic in this operation, under similar conditions, at least six of the workers would have been over-exposed. Therefore, each job site and materials must be judged on an individual basis.

Although no workers were over-exposed at this worksite, there are some improvements that could be made to further reduce exposure:

1. At most roofing jobs, the kettle is located as close as possible to where the hot is needed. Unfortunately, this also results in the fumes dispersing into the workers' breathing zone. When feasible, the kettle should be located away from the immediate work site or possibly downwind.

2. Scheduling the work so that all carpentry and miscellaneous work is completed before the actual roofing begins will reduce the number of employees exposed.

3. It may not be possible at some worksites, but when it is feasible, use the direction of ambient breezes to the fullest to reduce exposures. An example would be to always lay up the roof into the wind.

4. The amount of fumes from the kettle is closely related to the temperature of the material in the kettle. Keeping this temperature at an absolute minimum to meet the roof top material temperature specification should always be the goal of the kettleman. During this project, the kettle temperature reached 600°F at times, when the specification temperature was 450°F.

X. REFERENCES

1. National Institute for Occupational Safety and Health (NIOSH), Manual of Analytical Methods, Second Edition, Volume 1, DHEW (NIOSH) Publication No. 77-157A.

2. National Institute for Occupational Safety and Health (NIOSH), Manual of Analytical Methods, Supplement to the Third Edition, HHS (NIOSH) Publication No. 84-100.

3. National Institute for Occupational Safety and Health (NIOSH), Criteria for a Recommended Standard, Occupational Exposure to Asphalt Fumes, DHEW (NIOSH) Publication No. 78-106.

4. Threshold Limit Values for 1985-86, American Conference of Governmental Industrial Hygienists, ISBN: 0-936712-61-9.

XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted by and Reported Prepared by:	George A. Carson, Ph.D., CIH Industrial Hygiene Engineer NIOSH, Region VII
Report Typed by:	Mary Kelso NIOSH, Region VII

XII. 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), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the above address.

Copies of this report have been sent to:

A. Office of Safety, Kansas City District, U.S. Army Corps of Engineers

B. NIOSH, Region VII

C. U.S. Department of Labor/OSHA, Region VII

TABLE I

PERSONAL SAMPLE - SOLUBLE CONCENTRATIONS

Corps of Engineers Supply Depot

HETA 83-198
July 1985

Sample #	Sample Location	Date	Sampling Period	Vol. m3	Lab Result mg/Sample	Conc. mg/m3
6A	Supervisor Layup Roof Level	3/28	0936-1500	.61	0.12	.19
7A	Worker Layup Roof Level	3/28	0930-1454	.56	0.06	.11
8A	Kettleman Ground Level	3/28	0910-1400	.62	0.38	.61
9A	Worker Spudding Roof Level	3/28	0903-1447	.74	0.10	.14
10A	Worker Carpenter Roof Level	3/28	0815-1453	.91	0.32	.35
12A	Worker Layup Roof Level	3/28	0933-1454	.73	0.06	.08
14A	Worker Hot Carrier Roof Level	4/18	0930-1454	.68	0.06	.09

TABLE I
(Continued)

Sample #	Sample Location	Date	Sampling Period	Vol. m3	Lab Result mg/Sample	Conc. mg/m3
16A	Worker Mopping Roof Level	4/18	0922-1457	.69	0.06	.09
18A*	Worker Cutting & Piecing - Roof Level	4/18	0959-1454	.53	0.04	.08
22A	Worker Mopping Roof Level	4/18	0932-1455	.74	0.06	.08
24A	Worker Roll Out Roof Level	4/18	1002-1458	.39	1.06	2.7
25A	Worker Kettle Ground Level	4/18	0920-1445	.56	0.02	.04
28A	Worker Patching Roof Level	4/18	0957-1455	.54	0.02	.04
40A	Worker Kettle Ground Level	4/19	0845-1500	.80	0.66	.83
41A	Worker Layup Roof Level	4/19	0845-1500	.76	0.12	.16
42A	Worker Roof Level	4/19	0840-1500	.78	0.60	.77
43A	Worker Layup Roof Level	4/19	0843-1500	.57	0.04	.07

TABLE 1
(Continued)

Sample #	Sample Location	Date	Sampling Period	Vol. m3	Lab Result mg/Sample	Conc. mg/m3
44A	Worker Layup Roof Level	4/19	0842-1500	.87	0.16	.18
45A	Worker Layup Roof Level	4/19	0842-1500	.70	0.26	.37

* Pump was not operating at end of sampling period.

TABLE II

AREA SAMPLE - SOLUBLE CONCENTRATIONS

Corps of Engineers Supply Depot

HETA 83-198
July 1985

Sample #	Sample Location	Date	Sampling Period	Vol. m3	Lab Result mg/Sample	Conc. mg/m3
11A	On Roof above Kettle	3/28	0940-1505	.81	0.12	.15
13A	On Roof away from Kettle	3/28	0918-1440	.64	0.04	.06
15A	On Roof above Kettle	4/18	0840-1500	.91	0.02	.02
26A	On Roof Downwind from Kettle	4/18	0843-1500	.75	0.02	.03
46A*	Adjacent to Kettle	4/19	0820-1200	.44	1.34	3.0
47A	On Roof Downwind from Kettle	4/19	0825-1455	.78	0.10	.13
48A	On Roof above Kettle	4/19	0825-1455	.84	0.34	.40

* Pump was not operating at end of sampling period.

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 PAID
U.S. DEPARTMENT OF HHS
HHS 396