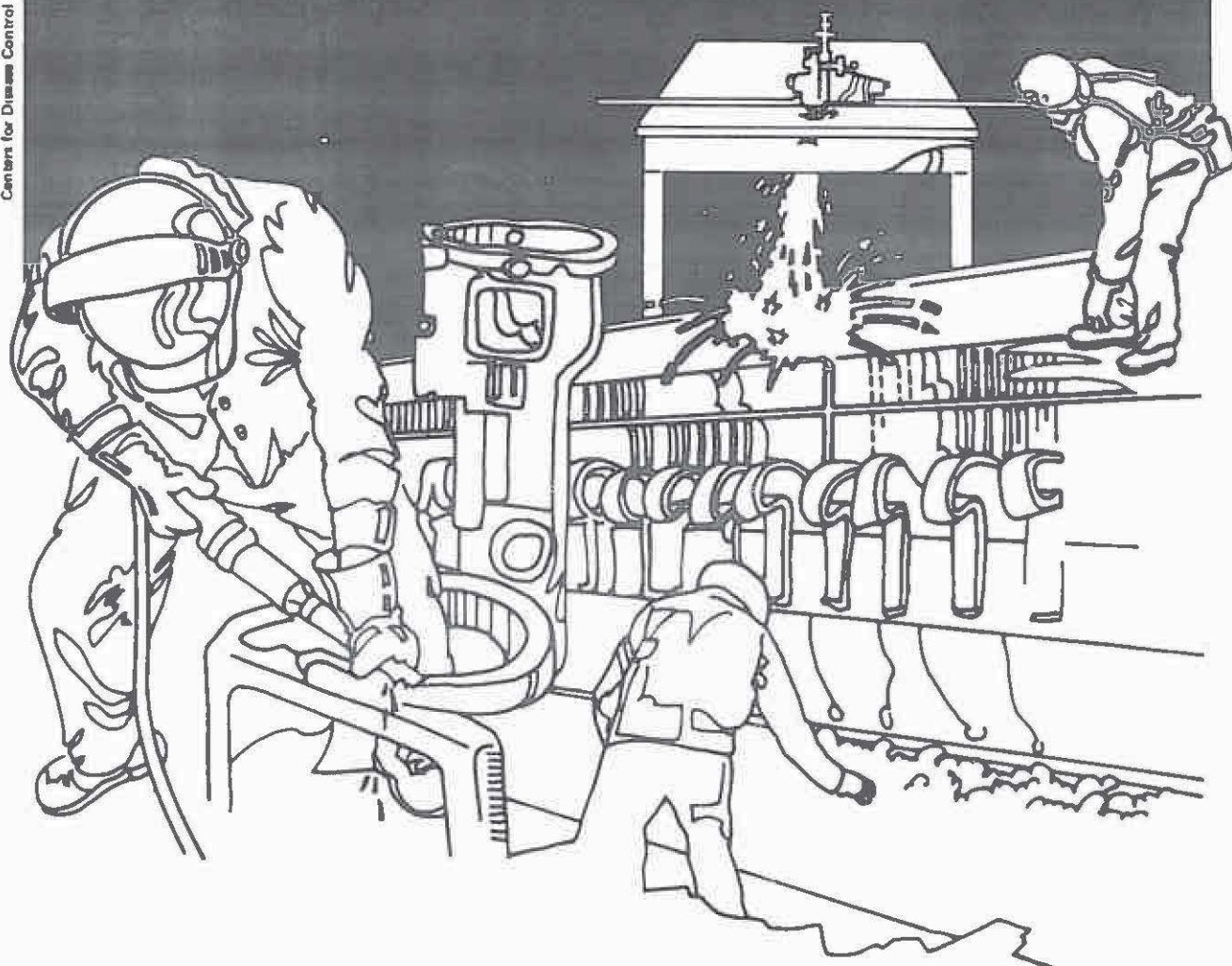


# NIOSH



## Health Hazard Evaluation Report

HETA 80-206-1164  
MID-SOUTH TERMINALS  
MEMPHIS, TENNESSEE

## 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.



## I. SUMMARY

On July, 1980, the National Institute for Occupational Safety and Health (NIOSH) was requested by Local 1671 of the International Longshoremen's Association, Memphis, Tennessee to evaluate reported skin and eye irritation resulting from exposure to coal tar pitch and petroleum pitch (asphalt) among workers involved in transfer operations at Mid-South Terminals Corporation in Memphis. Eight to 10 workers are involved in the transfer of granular pitch to-and-from water-going vessels. Transfers usually occur once every two to three weeks and normally take 2 shifts for each transfer.

NIOSH conducted site visits on August 20-21, 1981 (coal tar pitch transfer) and on October 12-13, 1981 (petroleum pitch transfer) to evaluate exposures and health complaints. Personal breathing zone (PBZ) and area air samples were obtained for total and respirable pitch dust, benzene solubles, polynuclear aromatic hydrocarbons (PNAs) and organic vapors. Work practices, personal protective measures and equipment were also evaluated. A NIOSH physician interviewed and examined 26 employees (11 pitch and 15 currently non-pitch workers).

Total pitch dust exposures ranged from 0.04-6.80 milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) (mean = 1.15) for 10 PBZ samples. Two results (9.52 and 10.1  $\text{mg}/\text{m}^3$ ) were considered questionable and not included in the previous range of exposures. Area samples documented total pitch dust concentrations up to 8.40  $\text{mg}/\text{m}^3$  in the immediate work area. Benzene solubles results ranged from 0.05-1.47  $\text{mg}/\text{m}^3$  for the petroleum pitch samples. All of the coal tar pitch benzene soluble exposure results approximated or exceeded the NIOSH 0.1  $\text{mg}/\text{m}^3$  exposure criteria. The NIOSH asphalt fume exposure criteria of 5  $\text{mg}/\text{m}^3$  was not exceeded during the petroleum pitch operations.

The following 8 PNAs were quantified in air samples; benzo(k)fluoranthrene, benzo(b)fluoranthrene, pyrene, benzo(a)anthracene, chrysene, benzo(e)pyrene, benzo(a)pyrene, and fluoranthrene. Air concentrations ranged from 0.02-44.9 micrograms per cubic meter ( $\text{ug}/\text{m}^3$ ). Results indicate that the pitch operations generate respirable size particles which have a benzene soluble fraction ranging from 0.09-0.18  $\text{mg}/\text{m}^3$ . Six PNA's in a concentration range of 0.02-0.07  $\text{ug}/\text{m}^3$  were identified in 2 respirable benzene solubles samples. Protective equipment was considered adequate. Deficiencies were noted in work practices.

Skin and eye irritation were reported almost universally by the workers who participated in the NIOSH study. The eye irritation was usually characterized by burning, redness, swelling, and watering of the eyes, lasting about 2 days. Photophobia was occasionally present. Skin irritation (neck, face, nose, forearms, lips) was characterized as a redness, like a sunburn, lasting 2-3 days, sometimes with drying or peeling by the third or fourth day. White workers were more severely affected than black. Skin lesions, possibly pitch-induced were observed in 4 workers. There was some indication that the sun screen lotion recommended after the first visit was beneficial.

Even though the pitch transfer operations only occur once every 2-3 weeks, working with the pitch without the appropriate personal protective equipment would be considered a health hazard. Handling the pitch at night and the use of personal protective equipment has decreased the associated health risks, but acute health effects are still occurring especially when available protective equipment is not utilized. Recommendations for further minimizing exposures are presented in Section VIII.

KEYWORDS: SIC 4463 (Marine Cargo Handling); coal tar pitch, petroleum pitch, benzene solubles, phototoxic, photosensitivity, phototoxicity, ultraviolet light, PNAs



## II. INTRODUCTION

In July, 1980, Local 1671 of the International Longshoremen's Association submitted a request to the National Institute for Occupational Safety and Health (NIOSH) to evaluate health effects and exposures resulting from the coal tar pitch and petroleum pitch transfer operations at Mid-South Terminals Corporation, Memphis, Tennessee. The primary health effects reported included skin and eye irritation which were most noticeable when the pitch transfers occur during the day shift but also of concern during the second shift operation.

Initial field response was delayed first in late 1980 due to OSHA activity at the facility and later (spring, 1981) due to a low water level which prevented barges from approaching the terminal area. Additional delays resulted from scheduling conflicts. The coal tar and petroleum pitch transfers, although pre-scheduled, did not always occur on the days scheduled, and on two occasions, last minute schedule changes resulted in cancellation of NIOSH field surveys. An initial survey was conducted in August, 1981 by a NIOSH team consisting of an Industrial Hygienist and an Occupational Physician at which time a coal tar pitch transfer was in progress. A follow-up survey was conducted in October, 1981 to evaluate a petroleum pitch transfer operation. Due to a large backup of "special organic" analysis at the NIOSH contract laboratory the last set of air sampling results for benzene solubles and PNA's were received in March, 1981. However, recommendations for minimizing exposure to the pitch dust were forwarded to management and labor representatives in November, 1981. Work practices, use of sun screen lotion and personal protective equipment were addressed.

## III. BACKGROUND

Mid-South Terminals Corporations operates a river terminal at Memphis, Tennessee. The primary activity involves the transfer of a variety of substances to-and-from water-going vessels and land transport vehicles such as trucks and railroad cars. Cargo is also moved in and out of large storage warehouses located near the dock. The water level is 15-20 feet below dock level; therefore, transfer to-and-from water-going vessels is accomplished through the use of cranes, drop chutes, and slides. Approximately 60 employees work at the terminal which is normally a 5-day, 8:00a-4:30p operation. Second shift and weekend operations can occur depending on scheduling priorities and the type of material being transferred. This health hazard evaluation studied only the coal tar and petroleum pitch transfer operations.

For the last several years, an attempt has been made to conduct these operations on second shift to minimize the health effects experienced by the workers involved in the direct transfer of the pitch as well as the health effects experienced by other dock workers resulting from the

fugitive pitch dust which can, depending on the wind direction, contaminate a large part of the dock area.

#### Coal Tar Pitch Transfer

On August 20 and 21, 1981, second shift, seven workers were studied during the transfer of coal tar pitch from a river barge to an ocean barge, by crane. The workforce included: 1 foreman, 1 crane operator, 1 checker (obtains measurements to insure that the barge load is distributed properly), and 4 stevedores (assist the crane operator in positioning the barge and movement of barge covers). The two barges are positioned side by side. A crane bucket is repeatedly filled from the river barge and emptied into the ocean barge. Towards the end of the transfer, one stevedore is lowered into the river barge in a bobcat to gather residual pitch into one pile so it can more easily transferred with the crane bucket. All seven workers are potentially exposed to pitch dust.

#### Petroleum Pitch Transfer

On October 13, 1981, second shift, eight workers were studied during the transfer of petroleum pitch from railroad car to ocean barge. The workforce included: 1 crane operator, 1 engine (train) operator, 1 foreman, 1 checker, and 4 stevedores. The railroad cars were positioned over a hole in the dock in such a manner so that when a trap door at the bottom of a compartment in the railroad car is opened the pitch falls through the hole in the dock onto a conveyor which carries the pitch to the edge of the dock, where it drops through a canvas chute in to the barge. In addition to the activities on the barge, the stevedores open and close the trap doors on the railroad cars and insure that the pitch dust maintains a constant flow onto the conveyor. When the flow stops, sledge hammers (used to pound on the side of the railroad car) and steel rods are used to get the pitch moving again.

Either a coal tar or petroleum pitch transfer occurs once every 2 to 3 weeks and generally takes 2 shifts to complete.

### IV. EVALUATION DESIGN AND METHODS

#### A. Environmental

Environmental sampling was conducted using personal breathing zone and area air sampling techniques to evaluate workers exposure to coal tar pitch (August 20-21, 1981) and petroleum pitch (October 20, 1981). In general, the sampling strategy was designed to measure airborne concentrations of pitch dust, benzene solubles, PNAs, and organic vapors. An attempt was made to determine if the pitch dusts contained a respirable fraction and if this fraction



contained a measurable quantity of benzene solubles and PNAs. Specific methods used included:

1. Bulk Analysis

A bulk sample of the coal tar pitch and petroleum pitch were each submitted for benzene soluble and PNA analysis. Each bulk was extracted with benzene. A portion of the extract was evaporated to dryness and weighed to determine the benzene solubles. Another portion of the dried extract was redissolved in acetonitrile and analyzed for specific PNAs by high-pressure-liquid-chromatography techniques.

2. Total and Respirable Pitch Dust

Personal breathing zone and area air samples for total pitch dust were collected on preweighed M-5 filters at a flow rate of 1.5-2.0 liter per minute (Lpm). Respirable pitch dust samples were collected on M-5 filters using 10 mm cyclones at a flow rate of 1.7 Lpm. All filters were analyzed gravimetrically.

3. Organic Vapors

Area air samples were collected on 150 mg charcoal tubes at a flow rate of 100 cubic centimeters per minute (cc/min) and analyzed by gas chromatography (FID) using a 25 meter methyl silicone fused silica capillary column. Of particular interest was whether or not low-boiling PNAs such as anthracene and naphthalene were present.

4. Benzene Solubles/PNAs

Personal breathing zone and area air samples for benzene solubles and PNA's were collected on glass fiber/silver membrane filters at a flow rate of 1.0-1.5 Lpm. The benzene soluble fraction was determined by NIOSH Method P&CAM 217. The PNA's were analyzed by liquid chromatography (NIOSH Method P&CAM 206).

B. Medical

The NIOSH physician interviewed and examined a total of 26 employees during the coal tar pitch and petroleum pitch transfers. The employees were evaluated by (1) questionnaire and (2) a brief physical examination of the skin and eyes. The medical questionnaire included an inquiry into previous and current symptoms related to the skin, eyes, nose, throat, and lower respiratory system, into the use and effect of personal protective equipment and what the cause for the symptoms might be.

## V. TOXICOLOGY AND EVALUATION CRITERIA

### A. Toxicology

#### 1. Coal Tar Pitch

Coal tar is a coproduct of the destructive distillation of coal. Coal tar pitch is a residue from the fractional distillation of coal tar and is estimated to contain thousands of compounds of which only about 300 have been identified. The coal tar pitch evaluated during this survey was received from Koppers in granular form. The benzene soluble fraction of coal tar pitch has been shown to contain substances referred to as polynuclear aromatic hydrocarbons (PNAs). The potential adverse health effects of these fused carbon ring compounds are well recognized,<sup>1-3</sup> and can be classified as either acute or chronic.

Regarding the latter, several PNAs such as benzo(a)pyrene, benzanthracene, and pyrene have been shown to be carcinogenic in animals. Moreover excess risk for lung cancer, oral cancer, and skin neoplasms (benign and malignant) have been found in working populations handling coal tar products which NIOSH has defined to include coal tar, coal tar pitch, and creosote.<sup>2</sup>

The acute toxic effects of exposure to coal tar pitch include skin and mucous membrane irritation mediated directly and more noticeably through photosensitivity reactions of the phototoxic type involving an interaction between the photosensitizing agent (PNAs) and ultraviolet (UV) radiation. Most phototoxic reactions require UV-A (320-400nm). The mechanism involves the absorption of this radiant energy by the skin and by the PNAs on the skin which can then result in cell changes.<sup>1</sup> As expected, these reactions affect outdoor workers who handle these materials and receive exposure to sunlight. Thus these reactions are more frequent and severe in the summer and during mid-day when UV radiation is most intense. The effects most often described include erythema (reddening of the skin) and burning and itching of the skin, photophobia and conjunctivitis. Typically, onset of symptoms may be delayed until the day after exposure when the pitch worker goes outdoors and receives UV light that can interact with the PNAs on the skin. Elimination of either the light or contact with the phototoxic substance eliminates the problem. Increased skin pigmentation (melanin) such as in blacks has been shown to have a protective effect.



## 2. Petroleum Pitch

Petroleum pitch, often referred to as asphalt, is the residue from the fractional distillation of petroleum products. The petroleum pitch evaluated in this survey was a granular product received from Mobil-Ashland. The reported biological effects of petroleum pitch have been viewed as confusing and contradictory due to the failure to distinguish between petroleum pitch and coal tar pitch.<sup>2</sup> There is general agreement that petroleum pitch is substantially less toxic than coal tar pitch, presumably because the petroleum pitch has fewer identifiable PNAs and in lower concentrations. None of the reports in the literature which were cited in the NIOSH Criteria Document on Asphalt Fume<sup>2</sup> demonstrated conclusively that asphalt fume has carcinogenic potential in man or animals. Skin, eye, and respiratory effects have been reported in those involved in paving and roofing operations but to a much lesser extent.

Occupational exposures to coal tar and petroleum pitch studied in the past have generally been during heated processes involving pitch volatiles. There has been less research into these pitches during non-heated exposures (two investigations are summarized in the Discussion<sup>3,8</sup>).

## B. Criteria

### 1. General Comments

A number of sources recommend airborne levels of substances under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Such airborne levels are referred to as standards or threshold limit values (TLV's). It is believed that concentrations below these limits represent conditions under which nearly all workers may be repeatedly exposed 8 to 10 hours per day, 40 hours per week, without suffering adverse health effects. Due to variations in individual susceptibility, a small percentage of workers may experience effects at levels at or below the threshold limit; a smaller percentage may be more seriously affected by aggravation of a pre-existing condition or by a hypersensitivity reaction.

The three main sources of criteria for this study are: (1) NIOSH Criteria Documents with recommended standards for occupational exposure; (2) General Industry Safety and Health Standards, U.S. Department of Labor, OSHA;<sup>6</sup> (3) Threshold Limit Values (TLV's), and their supporting documentation, issued by the American Conference of Governmental Industrial Hygienists (ACGIH).<sup>7</sup>



## 2. Coal Tar and Petroleum Pitch Criteria

The following criteria are available for consideration of coal tar and petroleum pitch (asphalt) exposures.

### Coal Tar

Substance	Criteria*	Source	Comment
1. Coal Tar Pitch Volatiles (CTPV)	0.20 mg/m <sup>3</sup>	OSHA	heated process
2. CTPV	0.20 mg/m <sup>3</sup>	ACGIH	heated process
3. Particulate Polycyclic Aromatic Hydrocarbons	0.20 mg/m <sup>3</sup>	ACGIH	heated process
4. Coal Tar Products	0.10 mg/m <sup>3</sup>	NIOSH	not specified
5. Coke Oven Emissions	0.15 mg/m <sup>3</sup>	OSHA	heated process
6. PNAs	see Note (a)		

\* Expressed as benzen or cyclo hexane solubles.

Note (a): Only benzo(a)pyrene and chrysene have been addressed directly. A TWA of 0.2 ug/m<sup>3</sup> was recommended by the coke oven advisory committee for benzo(a)pyrene under the OSHA 29 CFR 1910.1029 coke oven emissions standards, but was not adopted;<sup>2</sup> and a special NIOSH hazard review of chrysene recommended that it be controlled as an occupational carcinogen. Also, ACGIH has added chrysene to its list of industrial substances suspect of carcinogenic properties for man.<sup>7</sup> The carcinogenic potential of the other polycyclic aromatic hydrocarbons (benzo(a)anthracene, anthracene, pyrene, and fluoranthene) has also been documented.<sup>2</sup>

### Petroleum Pitch (Asphalt)

Substance	Criteria	Source
Asphalt Fumes	5 mg/m <sup>3</sup>	ACGIH
Asphalt Fumes	5 mg/m <sup>3</sup>	NIOSH

The selection of exposure criteria for the substances evaluated during this study is not as straightforward as with many other substances. Most of the available criteria for both coal tar and petroleum pitch have been generated and applied for work exposure situations where a material is heated thereby volatilizing the coal tar or petroleum pitch. The operation

evaluated during this study involved exposure to coal tar and petroleum pitch dust at ambient temperatures.

The chemicals of concern in coal tar or petroleum pitch are large molecule, polycyclic hydrocarbons commonly referred to as polynuclear aromatic hydrocarbons (PNAs). Several PNAs are known carcinogens and there are potentially thousands of PNAs in coal tar pitch. The PNAs that have been identified are soluble in benzene. By limiting exposure to benzene solubles, PNA exposures, and therefore, cancer risks are thought to be minimized.

NIOSH has recommended that cyclohexane be substituted for benzene due to the high toxicity of benzene. At the time of this writing, analytical data suggests that benzene solubles and cyclohexane solubles results would be expected to be similar for air samples but can be different for bulk samples. It is presumed that this is due to sample mass-to-solvent ratio. For example, in a bulk analysis where 10 grams of a bulk material may be dissolved in 50 grams of solvent (20% solution), the amount of hydrocarbon material dissolved in the solvent will be affected by solubilities of the individual components of the pitch. Whereas, with an air sample, the solvent/hydrocarbon mass ratio is so much greater that essentially 100% of the PNAs are expected to be dissolved in either benzene or cyclohexane. Benzene was used in this study because it was thought to be a better solvent for the bulk analysis. The air samples were also extracted with benzene to maintain consistency.

### 3. Criteria Selected for this Study

The NIOSH criteria for coal tar products ( $0.1 \text{ mg/m}^3$ , cyclohexane solubles) and asphalt fume ( $5 \text{ mg/m}^3$ ) were used as a guide in evaluating employee exposure to the pitch dusts; however, analysis for specific PNAs influenced interpretation of exposure data.

## VI. RESULTS

### A. Environmental

#### 1. Bulk Analysis

The benzene soluble fraction was determined to be 57% for the coal tar pitch and 97% for the petroleum pitch.

The following PNAs (with concentrations) were detected in the benzene soluble fraction of the bulk samples. The lower limit of quantification (LOQ) for a given PNA was 0.5 ppm.



Compound	Concentration (ppm) By Weight
Coal Tar Pitch	
Phenanthrene	5.4
Anthracene	1.5
Benzo(k)fluoranthrene	11.2
Benzo(b)fluoranthrene	22.4
Pyrene	14.3
Benz(a)anthracene	8.4
Chysene	19.6
Benzo(e)pyrene	14.3
Benzo(a)pyrene	16.0
Petroleum Pitch	
Anthracene	<0.5
Phenanthrene	<0.5
Fluoranthene	1.1
Pyrene	1.5
Benz(a)anthracene	1.2
Chrysene	1.2

While the benzene soluble fraction of the petroleum pitch was much greater (97% compared to 57% for the coal tar pitch) the number and concentration of PNAs was much less. This has been attributed to different thermal histories. Maximum temperatures during the production of petroleum pitch is 350 to 450°C and greater than 1000°C for coal tar pitch.

## 2. Total and Respirable Pitch Dust

It should be noted that all of the workers monitored were wearing protective equipment, including respirators, while working in dusty areas. Therefore, the data presented in Tables I and II and summarized below does not reflect actual exposures. The data would represent exposures for a worker not wearing protective equipment.

Total airborne particulate results ranged from 0.04 to 9.52 mg/m<sup>3</sup> for the 11 samples obtained during the coal tar pitch transfer and 0.18 to 10.1 mg/m<sup>3</sup> for the 8 samples obtained during the petroleum pitch operation. Respirable airborne particulate results ranged from not detectable to 0.33 mg/m<sup>3</sup> for the 7 coal tar pitch transfer samples. Two petroleum pitch samples were ND and 0.16 mg/m<sup>3</sup>.

### 3. Organic Vapor

Anthracene and naphthalene were not detected in any of the seven air samples submitted for organic vapor analysis. Traces of toluene were present but not in amounts high enough to be quantitated.

### 4. Benzene Solubles/PNAs

Total benzene solubles results ranged from 0.05 to 1.47 mg/m<sup>3</sup> for the 12 air samples obtained during the coal tar pitch transfer and 0.11 to 2.40 mg/m<sup>3</sup> for the 7 air samples for the petroleum pitch. The 5 samples obtained to determine if there were benzene solubles in the respirable fraction of the pitches ranged from ND to 0.18 mg/m<sup>3</sup>.

If results are rounded to the nearest tenth, all benzene solubles results equalled or exceeded the NIOSH 0.1 mg/m<sup>3</sup> coal tar products criteria. However, the criteria applies to a 40-hour workweek and the transfers normally occur every 2 to 3 weeks for 16 to 20 hours.

The following 8 PNAs were quantified in the air samples obtained during the coal tar and petroleum pitch transfer operations (Tables I and II).

PNA	Concentration range (ug/m <sup>3</sup> )	Transfer Operation
Benzo(k)fluoranthrene	0.02 - 12.88	Coal Tar
Benzo(b)fluoranthrene	0.05 - 34.76	Coal Tar
Pyrene	0.46 - 44.99	Coal Tar and Petroleum
Benzo(a)anthracene	0.11 - 34.76	Coal Tar and Petroleum
Chrysene	0.32 - 26.58	Coal Tar
Benzo(e)pyrene	0.09 - 38.85	Coal Tar
Benzo(a)pyrene	0.11 - 38.85	Coal Tar
Fluoranthrene	0.93 - 3.72	Petroleum

Six of the eight samples for benzo(a)pyrene exceeded the proposed OSHA standard of 0.2 ug/m<sup>3</sup> which, as mentioned in section V has not been promulgated. Phenanthrene and anthracene were detected but not present in quantifiable amounts. Specific PNA analysis was not run on several benzene soluble extracts based on a prioritization procedure which was applied at the request of the laboratory. The concentration of PNAs in the bulk pitch and the limit of detection of the



analytical method were combined to arrive at a benzene solubles quantity that would be necessary to have detectable amounts of PNAs. This level was set at 0.5 mg benzene solubles for the petroleum pitch air samples.

5. Work Practices/Personal Protective Equipment Program

The personal protective equipment available for use by the pitch handlers included hard hats, goggles, disposable respirators, disposable coveralls, disposable hoods and gloves. There was also a powered-air-purifying respirator unit for use by the bobcat operator. A barrier cream, which did not contain sunscreen, was available but was generally not used as it was felt to aggravate the effects of the pitch. Goggles were frequently lifted up and positioned on the hard hat which lead to pitch contamination of the goggle/face seal area. In some cases, goggles were re-used. The outside and, to some degree, the inside of gloves became contaminated quickly which resulted in prolonged skin contact. Although shower facilities were available, very few workers showered after handling pitch and in most instances work clothing was worn home. Coveralls offered some protection but the clothing worn under the coveralls was still contaminated.

B. Medical

1. Demographic Data

Of the 26 employees who participated, 11 were currently working with the pitch on one or both visits. The other 15 represented a random sample of approximately half of the remaining Mid-South employees (i.e., not handling the pitch on these two occasions). All the employees were male, their ages ranged from 20 to 56 (mean - 32.9 years). Five men were white and 21 were black. Ten described their occupation as stevedores, 6 were crane operators (heavy equipment operators), 4 were checkers, 3 were light equipment operators (fork lift), 1 bobcap operator, 1 maintenance, 1 combined heavy equipment operator/stevedore. Duration of employment ranged from 0.33 to 8 years (mean 2.6 years).

2. Symptoms

a. Past Symptoms

As the pitch transfer operations were generally considered unpleasant and had for the past year been performed on the evening shift (to decrease sun and ultraviolet light exposure), workers currently handling the pitch tended to be those with least seniority. All except 4 of the 26

employees examined had handled the pitch at some time in the past. The prevalence of past symptoms is shown in Table III.

Complaints of skin and eye irritation were essentially universal. It was also emphasized by workers that exposure to skin and eye irritation resulting from pitch dust was possible on the dock even when not directly handling the material, as it could be blown about and affect non-handlers.

The eye irritation was described as burning, redness, swelling, and watering of the eyes, lasting about 2 days. At times, an associated photophobia was present.

The skin irritation was characterized as redness like a sunburn, lasting 2 to 3 days, sometimes with drying and peeling by the 3rd or 4th day. The burning was often worse in the sun or on the next day following exposure, which is typical of photosensitivity reactions where an interaction with ultraviolet radiation occurs. Both black and white employees felt the white workers were more severely affected. The affected areas were usually sun-exposed: neck, face, malar area, nose, forearms, lips.

Only 2 individuals attributed these symptoms to any material handled other than the pitch. One felt corn and soy affected him as much as pitch and another reported fertilizer caused more problems than pitch. All others attributed the problem to pitch only.

b. Symptoms Present During NIOSH Visits

- 1) During the first visit (CTP transfer, August 1981), the day was cloudy and the wind was favorable (blowing out onto the river). No acute symptoms were reported.
- 2) During the second visit (petroleum pitch transfer, October 1981), the day was quite sunny and much windier. All of the pitch-exposed employees reported some skin/eye irritation (see Signs). There was some indication that the sun screen recommended after the first visit was beneficial.

c. Signs

1) Acute

No red eyes or affected skin were observed during the first visit. On the second visit, red, tearing



irritated eyes (acute conjunctivitis) was observed in 4 individuals handling the pitch. A crane operator, who did not wear goggles, was the most severely affected, with moderate photophobia. No such signs were observed in the non-pitch handlers. Some skin redness was also observed where the goggles contacted the facial skin.

## 2) Chronic

Skin lesions that were possibly pitch-induced were observed in 4 workers (see Table IV). The mean exposure in those with skin lesion was 3.9 years versus a mean of 2.3 years in the other 15 for whom exposure duration was known. This suggested a trend of increasing frequency of lesion with increasing duration (dose-response relationship) but the mean durations were not significantly different by t-test. It has been reported that 2 years experience with pitch is required to get such lesions (eg. pitch warts).<sup>9</sup> As seen in Table V, this dichotomy does not reach statistical significance but is still suggestive of an effect.

## VII. DISCUSSION

It should be noted that there are several pieces of environmental data that do not seem consistent with what was observed and/or other sampling data. For example, at least 2 total dust results (9.52 and 10.1 mg/m<sup>3</sup>) seem unreasonably high. The corresponding total benzene solubles (0.34 and 1.60 mg/m<sup>3</sup>) taken with a filter on the opposite lapel were much lower than expected based on analysis of the bulk pitches. For the air samples to be consistent, these total benzene solubles would have been expected to have been 5.43 and 9.80 mg/m<sup>3</sup>, respectively. This anomaly was also present in several other sample combinations and is unexplained. Also, several total benzene solubles samples were slightly higher than the corresponding total dust. This difference may be due to the orientation of each of the 2 samplers on the worker.

A previous Health Hazard Evaluation conducted in 1976<sup>3</sup> studied a roofing tear-off operation (a non-heated process) and found total dust levels of over 2 mg/m<sup>3</sup>, cyclohexane soluble levels of over 1 mg/m<sup>3</sup> and benzo[(a)+(e)]pyrene levels of up to 14 ug/m<sup>3</sup>. A high proportion of roofers gave a history of apparent skin photosensitivity, similar to the present HHE. A more recent Health Hazard Evaluation<sup>8</sup> that evaluated another roofing tear-off operation reported total dust exposures of 1.8 to 6.2 mg/m<sup>3</sup>, respirable dust levels of 0.67 to 1.7 mg/m<sup>3</sup>, cyclohexane solubles of ND to 0.51 mg/m<sup>3</sup> and 5 PNAs in concentrations up to 26 ug/m<sup>3</sup>. Workers reported phototoxic effects including skin erythema, photophobia, and conjunctivitis.

The current study at Mid-South found concentrations of total particulate, benzene soluble material, and specific carcinogens including benzpyrene in the same order of magnitude as these previous investigations. Moreover, a high prevalence of past symptoms, and acute conjunctivitis compatible with pitch/PNA-induced photosensitivity was observed. Finally, skin lesions that may be pitch-associated were found in 4 employees. Benzpyrene, of course, is only a well-known indicator for the many other specific PNAs present in such environments.

As an additional investigation not part of the 1976 HHE study design, NIOSH determined that both a respirable fraction of total particulate and of benzene soluble material was detectable. Thus, consideration must be given to recommendations for respiratory protection even though the operation is performed for only several days each month.

The natural history of the small "wart-like" lesions is such that they should be considered pre-cancerous. The vast majority stay the same or spontaneously regress, while a small percentage can progress to squamous cell carcinoma.<sup>4</sup> Thus, the management once found should be cessation of exposure, and removal of the lesion by biopsy excision and follow-up of biopsy site, or by physical destruction (liquid nitrogen or dessication and curretage) by a dermatologist.

#### VIII. RECOMMENDATIONS

The following recommendations are presented to minimize exposure to coal tar and petroleum pitch dust thereby reducing acute health effects as well as the potential for long-term health effects. Comments address four major areas: dust control, minimize contact with the pitch dust, protection against UV light, and medical monitoring.

##### A. Dust Control

1. Continue frequent hosing down the dock area to minimize re-entrainment of settled pitch dust.
2. Explore the possibility of using fine water sprays at points of dust generation.
3. Explore the possibility of using biodegradable agglomerating agents at dust generation points or possibly at the crusher operations where the pitch granules are produced. One such product is Deter Microfoam. In a coal dust application, cost of control was reported to be 2 to 5 cents per ton of coal. More information about this dust control technique is provided in Appendix A.



B. Minimize Contact With Pitch Dust

1. Use of personal protective equipment (hard hats, goggles, respirators, disposable suits with hoods, gloves and safety shoes) should be mandatory for those workers who need to be in areas of high dust concentration. Disposable respirators will provide an adequate level of protection considering the frequency of the transfer operations. Disposable cotton gloves may offer more protection from skin contact with pitch material than a reusable glove because pitch dust invariably will contaminate the inside of a reusable glove thereby prolonging skin contact. Goggles should not be reused unless the pitch contamination can be removed, especially from the goggle/face contact point. Once in place, goggles should be left on to preclude the excessive contamination on the face seal from raising the goggles up to the hard hat where pitch dust is usually heavy. A defogging agent will help prevent lens fogging.
2. Good personal hygiene is important. Employees (pitch workers) should shower and wash thoroughly with soap and water at the end of a shift, preferably at work. A complete change of clothes should be made after showering.
3. Skin contamination to pitch dust should be promptly washed with soap and water.
4. The life jackets worn while working down on the barges tend to get grossly contaminated. If they cannot be kept clean, they should at least be stored away from other gear and worn only for the pitch barge work. The disposable coveralls should adequately protect the wearer.

C. Protect Against UV Light

1. The coal tar and petroleum pitch transfers should continue to be scheduled on 2nd shift to minimize the phototoxic effects caused by UV light as well as minimize the number of workers exposed.
2. To prevent phototoxic reactions, sun screen such as those containing benzophenones should be applied to exposed skin. UVAL® (Dome Laboratories) and Solbar® (Person & Covey, Inc.) both contain benzophenones. The manufacturing of the former product has been recently discontinued. These should be applied approximately one-half hour before work and at mid-shift break.

D. Medical Monitoring

1. All employees exposed to pitch presently or in the past should have access to medical surveillance including an annual examination with medical and occupational history and physical exam with emphasis on the skin, eyes, and respiratory system.
2. When skin lesions are observed, employees should be referred to a dermatologist who is informed of the patient's exposure for follow-up as described in the Discussion. Letters have been sent to the four individuals with skin lesions suggesting they be seen by a dermatologist for removal of lesions.

IX. REFERENCES

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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. Mid-South Terminals Incorporated
2. Local 1671, International Longshoremen's Association
3. NIOSH, Region IV
4. OSHA, Region IV

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 I  
PARTICULATE, BENZENE SOLUBLE, AND PNA RESULTS

Coal Tar Pitch Transfer  
Mid-South Terminal

August 20-21, 1981

JOB/LOCATION	SAMPLE TYPE <sup>a</sup>	SAMPLE VOL.(m <sup>3</sup> )	PARTICULATES (mg/m <sup>3</sup> )		BENZENE SOLUBLES (mg/m <sup>3</sup> )		PHENAN	B(k)F	B(b)F	PNA's (ug/m <sup>3</sup> ) <sup>b</sup>				
			TOTAL	RESPIRABLE	TOTAL	RESPIRABLE				PYRENE	B(a)A	CHRYSENE	B(e)P	B(a)P
August 20, 1982														
Stevedore	P	0.44	1.17	--- <sup>c</sup>	0.05	---	ND	ND	0.05	ND	0.07	ND	0.09	ND
Stevedore	P(R)	0.48	---	0.11	---	ND <sup>d</sup>	ND	ND	ND	ND	ND	ND	ND	ND
On barge	A	0.49	3.4	---	1.47	---	ND	12.88	34.76	44.99	34.76	26.58	38.85	38.85
Crane op.	P	0.49	0.51	0.24	0.29	0.18	ND	ND	ND	ND	ND	ND	ND	ND
	P(R)	0.55	---	---	---	---	ND	ND	ND	ND	ND	ND	ND	ND
Edge of Dock	A	0.51	0.14	0.04	0.08	---	ND	ND	ND	ND	ND	ND	ND	ND
Bobcat op.	P	0.45	1.00	0.33	0.67	0.13	ND	5.77	12.00	15.56	13.33	9.56	14.89	14.22
	P(R)	0.45	---	---	---	---	ND	0.21	0.42	ND	0.27	0.27	0.47	0.18
August 21, 1982														
Stevedore #1, barge work	P	0.17	---	---	0.30	---	ND	0.40	1.10	1.05	1.16	0.81	1.28	1.63
Stevedore #2, barge work	P	0.53	0.30	---	0.08	---	ND	0.23	0.46	0.46	0.50	0.32	0.59	0.53
Stevedore	P	0.53	9.52	---	0.34	---	ND	0.99	1.71	1.90	1.90	1.37	2.29	1.90
Check clerk	P	0.45	0.42	---	0.09	---	ND	0.49	0.79	0.74	0.79	0.56	1.01	0.67
On barge	A	0.47	1.27	ND	0.09	0.09	ND	0.04	ND	ND	ND	ND	ND	ND
On barge	A(R)	0.46	---	---	---	---	ND	0.02	0.09	ND	0.11	ND	0.12	0.11
On dock	A	0.48	0.08	ND	0.12	---	ND	ND	ND	ND	ND	ND	ND	ND
Crane op.	P	0.46	0.04	ND	0.09	---	ND	ND	ND	ND	ND	ND	ND	ND
Lower Detectable Limit (micrograms per sample)							.06	.01	.02	.07	.03	.03	.03	.03
NIOSH Criteria (Full Shift, 40 hour week TWA)					0.1									
OSHA Standard (Full Shift, 40 hour week TWA)					0.2									

Note a P-breathing zone sample; P(R)-breathing zone sample respirable fraction; A-area sample; A(R)-area sample, respirable fraction  
b B(k)F-Benzo(k) fluoranthene; B(b)F-Benzo(b) fluoranthene; B(a)A-Benzo(a) Anthracene; B(e)P-Benzo(e) Pyrene; B(a)P-Benzo(a) Pyrene; Phenan-phenanthrene  
c Notation "----" means no sample of this type run  
d ND-no detectable levels found



TABLE II  
PARTICULATE, BENZENE SOLUBLE, AND PNA RESULTS

Petroleum Pitch Transfer  
Mid-South Terminal

October 13, 1981

JOB/LOCATION	SAMPLE TYPE <sup>a</sup>	SAMPLE VOL. (m <sup>3</sup> )	PARTICULATE (mg/m <sup>3</sup> )		BENZENE SOLUBLES (mg/m <sup>3</sup> )		FLUORANTHENE	PNA'S (ug/m <sup>3</sup> )		
			TOTAL	RESPIRABLE	TOTAL	RESPIRABLE		PYRENE	B(a)A	ANTHRACENE
Stevedore	P	0.41	0.72	--- <sup>b</sup>	0.73	---	*C	*	*	*
Stevedore	P	0.47	0.32	---	0.47	---	*	*	*	*
Checker	P	0.41	10.10	---	1.60	---	0.93	2.93	2.17	< 1.22
Stevedore	P	0.41	0.00	---	0.15	---	*	*	*	*
Engine Op.	P	0.37	0.18	---	0.11	---	*	*	*	*
Crane Op.	P	0.39	6.80	0.16	0.22	---	*	*	*	*
Edge of dock	A(R)	0.49	---	---	---	0.12	*	*	*	*
" " "	A	0.35	---	---	2.40	---	1.20	4.00	3.71	< 2.86
Down wind, 20 ft.	A	0.43	8.40	---	---	---	3.72	13.49	10.23	< 5.81
" " "	A(R)	0.48	---	0.00	---	---	*	*	*	*
Down wind, 30 ft.	A	0.31	3.57	---	---	---	*	*	*	*
Lower Detectable Limit (micrograms per sample)							0.08	0.12	0.04	0.20
NIOSH Criteria (Full shift, 40 hour week TWA)					5.0					
OSHA Standard (Full shift, 40 hour week TWA)					none					

Note: a P-breathing zone sample; A-area sample; A(R)-area sample, respirable fraction

b The notation "---" means this type of sample was not run

c The notation "\*" indicates that PNA analysis was not done because the benzene soluble fraction was < 0.5 mg and therefore, based on analytical detection limits, PNA's were not expected to be present in detectable amounts