U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-194-324

WESTERN ROOFING COMPANY, SELLERS & MARQUIS ROOFING COMPANY,
A.J. SHIRK ROOFING COMPANY, AND THE QUALITY ROOFING COMPANY;
A JOINT VENTURE
KANSAS CITY, MISSOURI 64130

AUGUST 1976

I. TOXICITY DETERMINATION

It has been determined that employees were exposed to toxic concentrations of particulate polycyclic organic matter (PPOM) as cyclohexane solubles during roofing operations involving the tear-off of an old roof on a seven acre facility at Lake City, Missouri. PPOM includes polynuclear aromatic hydrocarbons (PNA), benzo(a)pyrene (BaP) and benzo(e)pyrene (BeP). This determination is based on data collected during tear-off operations involving an old coal tar pitch roof during the medical-environmental survey conducted at Lake City on March 11, 1976, which included: (a) medical interviews and limited physical examinations; (b) environmental measurements for total and respirable nuisance dust, PPOM, PNA, BaP plus BeP, and alpha or beta naphthylamine; and (c) a review of available literature on PPOM, PNA, and BaP plus BeP.

Seventy-one percent of all examined roofers working on this project gave a history of apparent skin photosensitivity attributed to pitch dust exposures during this project. Ninety-two percent of the examined Caucasian roofers working on this project gave a history of apparent skin photosensitivity attributed to pitch dust exposures occurring during this project. Sixty-five percent of the examined roofers working on this project were observed to have conjunctivitis attributed to pitch dust exposures occurring during this project. These symptoms included lacrimation, chemosis, blepharospasm, lid swelling and blepharitis and conjunctival erythema. There was a statistically significant ($P<0.05$) association between the absence of conjunctivitis in workers exposed to concentrations of 0.11 milligrams per cubic meter (mg/M^3) of PPOM or less and the presence of conjunctivitis in workers exposed to PPOM concentrations of 0.18 mg/M^3 or greater.

A total of twenty-three (23) personal air samples were obtained on March 11, 1976, on fifteen (15) employees and varied from less than 0.01 mg/M^3 to a maximum of 1.88 mg/M^3 of PPOM which includes PNA and BaP plus BeP. Environmental results show that nine (9) of the fifteen (15) employees were exposed to concentrations exceeding the American Conference of Governmental

Industrial Hygienists (ACGIH) recommended Threshold Limit Value (TLV) of 0.2 mg/M^3 for PPOM. The maximum range of sample results was 0.059 mg/M^3 to 0.247 mg/M^3 for PNA. There is no ACGIH or Federal Occupational Health Standard for PNA. Environmental results show that eleven (11) employees were exposed to concentrations from 0.002 mg/M^3 to 0.018 mg/M^3 of BaP plus BeP. The actual concentration of BaP was not determined and, therefore, the results cannot be directly compared to the Standard Advisory Committee on Coke Oven Emissions' recommendation that employees not be exposed to BaP in excess of 0.0002 mg/M^3 on an eight-hour time-weighted average (TWA). However, based on the results obtained for BaP plus BeP, it appears possible that the exposure to BaP could considerably exceed the recommended level. All environmental results were less than 60 percent of the ACGIH recommended TLV's of 5 mg/M^3 and 10 mg/M^3 for respirable and total nuisance dust or particulate matter, respectively. No alpha or beta naphthylamine was detected in the environmental air samples or in the bulk samples and, therefore, are not considered as toxic.

Detailed information concerning the results of the medical-environmental evaluation conducted on March 11, 1976, and a previous cursory environmental survey conducted on March 10, 1976, are contained in the body of this report. Recommendations are included in this determination report which are designed to reduce employee exposure to a minimum.

II. DISTRIBUTION AND AVAILABILITY OF THE DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH; Division of Technical Services, Information Resources and Dissemination Section; 4676 Columbia Parkway; Cincinnati, Ohio 45226. Copies have been sent to:

(a) Western Roofing Company, Sellers and Marquis Roofing Company, A.J. Shirk Roofing Company, and the Quality Roofing Company; A JOINT VENTURE; Kansas City, Missouri 64130

(b) Authorized Representative of Employees

(c) U.S. Department of Labor - Region VII

(d) NIOSH - Region VII

For the purpose of informing the approximately twenty (20) exposed employees, this report shall be posted in a prominent place readily accessible to workers involved in the "A JOINT VENTURE" for a period of at least 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 699(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of the United Slate, Tile and Composition Roofers, Damp and Waterproof Workers Association, AFL-CIO, to evaluate employee exposure to various airborne particulate contaminants containing coal tar pitch during tear-off or removal operations involving an old coal tar pitch-graveled roof. The request was precipitated by employee concern regarding irritation of the skin and eyes, peeling of the skin, and possible exposure to cancer-producing agents in coal tar products during the removal operations of an old roof.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

"A JOINT VENTURE" (referred to as the company) is a group of four firms consolidated for business purposes to engage in the removal of old and installation of new roofs on old or new commercial and non-residential construction. The area of concern was the removal or tear-off of a seven (7) acre coal tar pitch gravel roof down to the felt or insulation barrier. The initial tear-off involved the use of a "scratching machine" which has metal ribbed disks to break up the initial pitch gravel layer down to the felt and/or insulation. It was followed by a "power broom machine" which sweeps the gravel-pitch debris into wind rows on the roof. The gravel pitch is then shoveled by hand into small tractor trailer waste carts called "work horses" and transported to the side of the building for discarding via an enclosed chute or a large pipe to the ground level. While loading the gravel pitch, the roof is scraped with shovels and other hand tools to assure the surface is properly prepared for subsequent installation of a 4-ply felt plus a top pitch-gravel layer. The gravel-pitch is then loaded on a truck for disposal. A large power vacuum machine is used to clean the debris and finer dusts during various operations. Two scratching machines (two operators), two power brooms (two operators), one power vacuum machine (two operators) and four or five tractor trailer waste carts (approximately ten utility operators) were in use during the medical-environmental survey. Two employees were assigned to the flashing or patching operation using hot coal tar pitch to repair felt and pitch areas where needed prior to installation of a new roof. Approximately 10,000 square feet of old roof may be removed per day with a crew of approximately twenty employees.

Operations not conducted at the time of this evaluation included the removal of approximately 60,000 square feet of bad insulation (not asbestos insulation) using power claws and roof cutters for stripping to the metal deck or to the vapor barrier, installation of insulation where necessary, and the installation of a new roof (primarily 4-ply felt-pitch layers plus top pitch-gravel layer).

B. Study Progress

An initial walk-through survey was conducted on January 27, 1976. It was determined that a comprehensive medical and environmental study was necessary to complete the evaluation. The comprehensive medical-environmental study was carried out on March 11, 1976. Some preliminary environmental data were obtained on March 10, 1976, under slightly different environmental conditions. The temperature on March 11, 1976, varied from approximately 46°F to 64°F (average 59°F) and the average relative humidity was estimated at 50 percent. There was an afternoon thundershower commencing at 2:00 p.m. at which time most air sampling was stopped. There was a morning fog which lifted and so it was sunny from 9:30 a.m. to 1:00 p.m. Winds were southeasterly at approximately 10 miles per hour. The temperature on March 10, 1976, varied from 44°F to 60°F (average 55°F) and the average relative humidity was estimated at 55 percent with no rain. Winds were variable at approximately 8 miles per hour. It was mostly sunny.

One of the main operations for reducing airborne particulates is the use of a water spray on the area involved in the removal or tear-off operations. Limited spraying with a hand-held hose was performed on both days with more water applied on March 11, 1976. There are different types of coal tar pitch used in roofing operations, a recent variety is a so-called "no burn" type which gives off less volatiles at operating temperatures. The "no burn" type of pitch was used during patching or flashing operations by the two employees involved. All operations (e.g., patching, scratching, vacuuming, sweeping, etc.) contribute to the general exposure of all employees as most employees are in the same general vicinity. On March 11, 1976, the filters from the power vacuum were cleaned with compressed air for about one half hour resulting in a cloud of fine particulate matter in the immediate vicinity. A previous request (Health Hazard Evaluation Determination Report No. 75-102-304)[1] covered the installation of a new roof on a large warehouse.

C. Evaluation Methods

1. Environmental Methods

Personal air samplers were used to evaluate employee exposures. The personal samplers were connected on or near the collar of the employee to collect a representative sample of air in the breathing zone of the workers. Samples were obtained for a sufficient period of time so that for all practical purposes the results may be considered as representative of an employee's exposure over an entire shift. General area samples were attached to the handles of the work horses and are not considered as the exposure levels for any worker.

Total particulate samples were obtained using a glass fiber filter followed by a silver membrane filter and a backup pad in a three-piece cassette with a flow rate of 1.7 liters per minute (lpm) using a MSA Model "G"

Pump. Some respirable particulate samples were also obtained using a 10 mm cyclone at a rate of 1.7 lpm. Several high volume silica gel and charcoal tube samples were obtained in series after the filter cassette with an average sampling rate of approximately 1.5 lpm. The lower sampling rate was necessary due to the high pressure drop through the filter plus silica gel or charcoal tube sampling train. All filter samples were analyzed gravimetrically for total particulates. All filter samples obtained were also analyzed for particulate polycyclic organic matter (PPOM) as cyclohexane solubles by using ultrasonic extraction (Sawicke's method)[2] and gravimetric techniques. Polynuclear aromatic hydrocarbon (PNA) levels were analyzed by a modified method[3] developed by NIOSH laboratories which is more specific than previous methods[4,5] for the higher molecular weight polycyclic aromatic hydrocarbons. The range of total PNA's present is reported by this modified method. In addition to analysis for PPOM and PNA on all samples, analysis was made for benzo(a)pyrene (BaP) plus benzo(e)pyrene (BeP) utilizing gas chromatography with flame ionization detection.[3]

Several low volume charcoal and silica gel tube samples (no pre-filter) were obtained with a low flow sipin pump at a rate of approximately 0.050 lpm. The charcoal tube samples were analyzed for high and low molecular weight organic compounds by gas chromatographic methods (PACAM 127)[6]. The silica gel samples were analyzed by gas chromatographic methods for alpha or beta naphthylamine (PACAM 168)[6] and BaP plus BeP. Results for BaP plus BeP are reported as a total as the analytical method does not distinguish between these compounds.

For purposes of this report, PPOM (as cyclohexane solubles) is considered equivalent to coal tar pitch volatiles (CTPV) or PPOM (as benzene solubles). It should be noted that benzene as well as cyclohexane also dissolves some aliphatic hydrocarbons as well as the polycyclic organic hydrocarbons. For most practical purposes the analytical results using benzene or cyclohexane are the same and the use of cyclohexane for analysis of CTPV or PPOM is preferred by several authorities[7,8,9,10]. Both the filters and backup pad for each sample were analyzed[1,11] together to obtain the total PPOM unless specifically noted otherwise.

2. Medical Methods

Seventeen (17) workers were interviewed and examined. Informed consent was obtained from each worker. A brief questionnaire was completed containing identification data and a detailed occupational history and a medical history of complaints related to work was obtained. Workers were specifically asked about skin and eye complaints, their relation to work, their past history of diseases of these organs and any drug therapy which might influence the development of symptoms. The circumstances under which skin and eye symptoms occurred was elicited for each worker.

Each examined employee completed a directed questionnaire administered by the physician. The questionnaire was administered in two portions; one relating to eye irritation, the other relating to skin irritation. Various job classifications and environmental and other factors were rated as to their importance in influencing the development of eye or skin symptoms from roofing operations. Each factor was rated as posing either a very bad

problem (associated with the development of the most severe symptoms), a bad problem (often associated with severe symptoms), as an occasional problem (associated with occasional discomfort) or as posing no problem. If the worker had no experience or opinion about a specific factor this was recorded as not known. In order to evaluate the role of the various factors in the production of these irritations, a response of a very bad problem was given a score of 5, a bad problem a score of 3, an occasional problem a score of 1 and no problem of 0. The aggregate score obtained was divided by the number of respondees to obtain an index of severity between the possible limits of 0 and 5. In order to obtain this score, only the responses of men who had worked in the roofing industry for at least one year were used.

A physical examination of the skin and eyes of each worker was performed, both early during the shift on March 11, 1976, and later towards the end of the shift.

D. Evaluation Criteria

1. Environmental Standards or Criteria

The evaluation standards and criteria which might be applicable to this evaluation are as follows: The Occupational Health Standards as promulgated by the U.S. Department of Labor, Federal Register, May 28, 1975, Title 29 Chapter XVII, Subpart G, Tables Z-1 and Z-2 (29 CFR 1910.1000); American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) for Chemical Substances and Physical Agents in its Workroom Environment for 1975; and the NIOSH Criteria Documents recommending occupational standards.

There is a Federal Occupational Health Standard for coal tar pitch volatiles of 0.2 mg/M^3. There is a criteria document on coke oven emissions which does not specifically address itself to the type of exposures sustained in roofing operations which are significantly different in several respects to those sustained by coke oven workers. The recommended TLV's promulgated by the ACGIH applicable to the principal individual substances used for this evaluation are:

SUBSTANCE	TLV 8-HOUR TIME-WEIGHTED AVERAGE (TWA) EXPOSURE STANDARD OR GUIDE - mg/M^3*
Total Nuisance or Inert Dusts (Particulate)**	10.0
Respirable Nuisance or Inert Dusts (Particulate)**	5.0
Particulate polycyclic organic matter (PPOM) as benzene solubles	0.2 (This limit is the same as the Federal Occupational Health Standard).

SUBSTANCE	TLV 8-HOUR TIME-WEIGHTED AVERAGE (TWA) EXPOSURE STANDARD OR GUIDE - mg/M^3*
Alpha or Beta Naphthylamine***	------
Benzo(a)pyrene**** - Skin (BaP)	------

* Milligrams of substance per cubic meter of air--mg/M^3.

** The TLV is based on nuisance or inert dusts. It is noted that dusts containing coal tar pitch should not be considered as a nuisance or inert type of particulate matter.

*** There are no ACGIH recommended TLV's for alpha or beta naphthylamine although both compounds are considered as carcinogens by the Occupational Safety and Health Administration (OSHA). In this regard, OSHA has strict standards (Refer to Standard 29 CFR 1910.1000 and 1910.1004 for the protection of workers involved in the manufacturing, processing, releasing, handling, or storing of any substance containing more than one-tenth of one percent of beta naphthylamine or more than one percent of alpha naphthylamine.

**** There is no ACGIH recommended TLV for BaP or BeP. However, BaP is a known carcinogen and the Standard Advisory Committee on Coke Oven Emissions[10] recommended that employees not be exposed to BaP in excess of 0.0002 mg/M^3 of BaP on an eight-hour time-weighted average.

Occupational health exposure limits for individual substances have been generally established at levels designed to protect workers occupationally exposed on an eight hour per day, 40 hour per week basis over a normal working lifetime. There are no ACGIH recommended TLV's, Federal Occupational Health Standards, or other health guides concerning PNA. Use of any of the above sources of criteria would not change any conclusions contained in this report.

2. Medical Standards or Criteria

In this study acute effects on the skin and eyes as a result of roofing or tear-off operations involving an old roof were evaluated. It is known that roofers suffer from photosensitization reactions on the skin as a result of exposure to pitch.[12,13] Eye irritation was also mentioned in the hazard request. This study was not designed to examine whether roofers suffer from an abnormal incidence of chronic skin and eye disease or of cancer. There is unpublished information that there may be an increased incidence of certain cancers amongst roofers; however, that study was not conclusive in defining any particular exposure which might be responsible.[14,15] On the other hand, roofers could be exposed to a number of materials which are cocarcinogens. It is also possible that an increased incidence of

skin cancer might be seen in roofers as a result of their simultaneous exposures to sunlight and the photosensitizers present in pitch.[16,17]

E. Evaluation Results and Discussions

1. Environmental Results & Discussions

a. Analytical Results of Filter Samples Obtained for Total Particulate, Respirable Particulate, PPOM, PNA and BaP plus BeP

Table I presents all of the sample results for the twenty-three (23) personal air samples (16 for total particulate and 7 for respirable particulate) obtained on fifteen (15) workers on March 11, 1976, and for the four (4) personal air samples (total particulate) obtained on four (4) workers on March 10, 1976. In general, most of the results for similar jobs were somewhat higher on March 10, 1976, than on March 11, 1976. This may reflect the observation that less water was used in wetting the roof surface on March 10, 1976, than on March 11, 1976. Only those sample results obtained during the medical-environmental survey conducted on March 11, 1976, are discussed below.

All of the sixteen (16) sample results were less than sixty percent of the ACGIH recommended TLV of 10 mg/M^3 for total nuisance dust. All of the seven (7) sample results were less than twenty percent of the ACGIH recommended TLV of 5 mg/M^3 for respirable nuisance dust. The error in the sample results for dust or particulate matter is approximately plus or minus 0.5 mg/M^3 and the results appear fairly consistent. These TLV's are for nuisance or inert dusts only. Dusts containing coal tar pitch particulate matter should not be considered as nuisance or inert type of dusts. The six (6) respirable dust sample results varied from approximately seven percent to twenty-three percent (average of 14 percent) of the results for the six comparable total dust samples from the same workers. This indicates that approximately fourteen percent of the total airborne dust was of a respirable size. The highest result of 5.9 mg/M^3 of total dust for the power vacuuming machine operator was probably due to a short term exposure to higher concentrations of dust while cleaning the filters from the power vacuum machine with compressed air.

The level of PPOM detected in the sixteen personal samples varied from less than 0.01 mg/M^3 to a maximum of 1.88 mg/M^3 (average of approximately 0.47 mg/M^3). These sample results showed that nine (9) of the fifteen (15) employees (i.e., power broom machine operators Nos. 1 and 2, scratching machine operators Nos. 1 and 2, power vacuum machine operators Nos. 1 and 2, hot pitch flashing operator No. 1, utility operators Nos. 3 and 4) were exposed to concentrations exceeding the ACGIH recommended TLV of 0.20 mg/M^3 for PPOM.

Table I also presents the personal sample results for the range of minimum to maximum concentrations for each sample for PNA which may be expected for these samples. There are no ACGIH recommended TLV's or other Federal

Occupational Health Standards for PNA. The estimated average range of exposure of employees varied from approximately 0.017 to 0.083 mg/M^3 for PNA.

The personal samples were also analyzed for BaP plus BeP as these compounds cannot be separated under laboratory conditions used in the determination. Sample results varied from none detected (<0.002 mg/M^3) to a maximum of 0.014 mg/M^3 for BaP plus BeP. At this level of detection we could identify BaP plus BeP in samples obtained on eleven (11) out of the fifteen (15) employees (i.e., power broom machine operator No. 2, scratching machine operator Nos. 1 and 2, power vacuuming machine operators Nos. 1 and 2, hot pitch patching-flashing operators Nos. 1 and 2, utility operators Nos. 2, 4 and 6, and the front end loader-truck driver) sampled. The actual concentration of BaP in these samples was not determined and thus the results cannot be directly compared to the recommendations of the Standard Advisory Committee on Coke Oven Emissions that employees not be exposed to BaP in excess of 0.0002 mg/M^3 on an eight-hour time-weighted average. However, based on the values obtained for BaP plus BeP, it appears possible that the exposure to BaP in tear-off operations could considerably exceed the recommended level for coke oven workers, since BaP was qualitatively identified in the bulk samples (refer to Section IV-E-1-d, following).

The filters and backup pads were analyzed separately on the two area samples and these results are as follows:

SAMPLE NUMBER	TOTAL DUST	PPOM mg/M^3	PNA mg/M^3	BaP plus BeP mg/M^3
F-17 filters	3.7	0.58	.022-.101	.007
F-17 pad	---	0.64	.002-.027	<.002
F-18 filters	4.9	0.41	.011-.054	.019
F-18 pad	---	0.21	.004-.034	<.002

The results of the area samples indicate that a significant amount of the PPOM (approximately 35 to 50 percent) was passing through the filters and being absorbed on the backup pad. However, the results also indicate that the majority of the more complex PNA and BaP plus BeP remains on the filter. Therefore, it appears that the lower molecular weight or less complex hydrocarbons were passing through the filters and being absorbed on the backup pad. This may be expected as the material collected is dust being generated at ambient temperatures.

b. Results of Silica Gel Tube Samples for Alpha or Beta Naphthylamine and BaP plus BeP

No alpha or beta naphthylamine was detected in the four (4) high and one (1) low volume silica gel tube samples with a minimum detection limit of 0.001 mg per tube for each compound. Analysis of the bulk samples of the coal tar pitch showed no detectable amounts (less than one tenth of one percent) of alpha or beta naphthylamine. Hence, alpha or beta naphthylamine

does not appear to present a problem for these operations. OSHA does have strict regulations covering materials containing more than 0.1 percent of one percent beta naphthylamine or more than one percent of alpha naphthylamine.

Eight (8) high and two (2) low volume silica gel tube personal samples were analyzed for BaP plus BeP with a minimum detection limit of 0.002 mg of BaP plus BeP per tube. No BaP plus BeP was detected on any of these samples.

c. Results of Charcoal Tube Samples for High and Low Molecular Weight Organic Compounds

Three (3) high and twelve (12) low volume personal air samples plus 1 high volume area sample were obtained using charcoal tubes and were analyzed for high and low molecular weight organic compounds. These samples were obtained to more fully identify the various components of the particulate matter to which roofers are exposed during tear-off operations. The high volume charcoal tubes were preceded by a filter sample. Only one of the twelve low volume samples showed any single substance in excess of the detectable limit of 0.05 mg per tube. This tube contained approximately 0.7 milligrams of organic compounds primarily aliphatic hydrocarbons. Three of the four high volume samples gave positive results. These results are summarized in Table II. It appears from the data in Table II that some of the lower molecular weight organic compounds may pass through the filters and backup pad. However, no definitive statement can be made concerning the higher molecular weight compounds.

d. Results of Analysis of Two Bulk Samples (Dust Bulk of Old Coal Tar Pitch on Old Roof and Hot Pitch Bulk of New Coal Tar Pitch Used for New Patching or Roofing Operations) Obtained During Operations on March 11, 1976

The bulk sample of the new coal tar pitch was obtained from the heated pot containing the pitch used for patching operations. The bulk sample of potential airborne dust generated from the roofing operations was obtained from the filter used in the power vacuum machine.

Initially, portions of each bulk sample were dissolved in carbon disulfide and gas chromatography was performed to obtain peak patterns. Both chromatograms appeared very similar, each bulk displaying six major components and numerous smaller peaks. The six major peaks were identified by mass spectrometry as: anthracene and/or phenanthrene, fluoranthene, pyrene, chrysene and/or benz(a)anthracene (BaA), benzo(k)fluoranthene and BaP plus BeP. The chemical similarity of mass spectral data for these listed pairs and the lack of gas chromatographic separation make it difficult to positively confirm the presence of one of these components over the other in the pair. Since the chrysene-BaA and BaP-BeP pairs could not be separated by gas chromatography, reverse phase liquid

chromatography was performed using a U.V. detector to ascertain which of these compounds were present. Results indicated that both chrysene and BaA were present as well as both BaP and BeP. Minor peaks indicated by mass spectrometry of both bulk samples included acenapthene, dibenzofuran, fluorene, carbazole, and various substituted PNA's such as methyl anthracenes, phenanthrenes, and pyrenes. The percent by weight of the bulk samples for each of the six major peaks are given in Table III. From Table III it is noted that 0.4 percent by weight of the old dust bulk sample was BaP plus BeP and 1.0 percent by weight of the new hot pitch bulk sample was BaP plus BeP. Both BaP and BeP were qualitatively identified in both samples. However, analysis using gas chromatography with flame ionization detection[3] (e.g., similar analysis as filter samples) show .028 percent by weight of the old dust bulk was BaP plus BeP and .032 percent by weight of the new hot pitch bulk sample was BaP plus BeP. The difference in analytical results may be partially due to the different extraction methods (e.g., carbon disulfide versus cyclohexane) used in the two analytical techniques.

2. Medical Results and Discussions

a. Demographic Data

All the examined employees were males whose ages ranged from 19 to 55 with a mean of 37. Thirteen men were white and four were black. All men gave their current occupation as roofing. The time spent as a roofer ranged from six months to 25 years with a mean of 11 years. Two men had been employed as roofers for less than 1 year, 3 for 1 to 5 years, 4 for 5 to 10 years, 3 for 11 to 20 years and 5 for 20 or more years. The examined men had worked on this particular project from 4 days to 3 weeks at the time of examination with a mean of 2 weeks.

On this particular job on the day of examination 3 men were employed as foremen; the other men were predominantly engaged in various aspects of the scratching and clean off operation including scratching machine operators (3), power broom operators (2), power vacuuming machine operators (2), hot pitch patching-flashing operators (2) and utility operators (5). The foremen and occasionally some of the other operators were responsible for wetting down the roof to reduce airborne dust. The men tended to work in different phases of the operation from time to time and might be involved in more than one task over the course of the shift.

On the day of examination, three employees were absent from work, in each case their absence was attributed to 'pitch burns', although the site visit team could not substantiate these diagnoses.

b. Skin Reactions

On a previous recent hazard evaluation[1] the clinical characteristics of the acute skin reactions of roofers were described. These are predominantly

'phototoxic' reactions produced by the action together of sunlight and volatile components of the pitch. Both sunlight and pitch are necessary to cause this type of dermatitis.

The factors which contribute to the skin irritation were subjectively analyzed by use of the questionnaire previously described. The mean scores obtained for each job classification as they influenced the development and severity of skin irritation from roofing operations are shown in Table IV.

The data shows that roofers feel the development of skin irritation varies with the type of roofing operation and with the particular job classification. In general, the most severe irritation is associated with scratching and tear-off operations, and irritation of lesser severity with new roof installation. In new roof installation those operations where pitch is used are associated with more severe irritation. Within tear-off operations the most severe irritations are associated with power broom operation, hand sweeping and operation of a power scratching machine. Black roofers complain of much less severe skin irritation than do white and 3 of the 4 examined black roofers had never experienced skin irritation associated with roofing operations. The mean scores obtained from the questionnaire regarding the subjective assessment of the influence of various roofing materials and environmental factors on the development of skin irritation on exposed areas of the skin from roofing operations are shown in Table V. Environmental factors most strongly associated included summer, sunny days and high humidity. Of the roofing materials indicated in the questionnaire, pitch was singled out as the major cause with some irritations from insulation and virtually none from gavel felt or asphalt. Although less irritating than the so-called old style pitch, the newer pitches loosely termed as 'no-burn' styles, were still considered more irritating than any other roofing materials indicated in the questionnaire. Using pitch at a higher temperature was associated with more irritation than pitch used at just above its melting point.

Twelve of the 17 examined workers (twelve of the thirteen white workers) complained of skin irritation which they attributed to work on this particular job. In each case the worker complained of burning on exposed areas of the body in the sun, attributed to the effects of pitch and sunlight. Additional symptoms included erythema (reddening) of the skin, burning of the face and lips, peeling in some cases and in one case blistering. No examined workers had needed time off the job or had sought medical attention for these symptoms. Four workers described the irritation as mild and occurring only on occasional sunny days. Four workers described skin irritation of fairly mild severity occurring most or every day and four workers described more severe irritation with a severe burning sensation of the face, lips and other exposed areas whenever they were in the sun. In two cases, there was subsequent peeling and in one case blistering.

Examination of 17 workers early in the shift revealed abnormal erythema in eight workers all of whom were white. The erythema with an intensity which varied from mild to severe was noted on exposed areas, particularly of the sides and folds of the neck, face and ears, including the folds around the nose and lips. A sharp cutoff was noted at the border of exposed and non-exposed skin. Peeling was noted in one of the eight men. Fourteen workers were examined at the close of the shift. Erythema was noted on the exposed skin of seven workers, in five of whom there had been erythema on exposed skin sites at the commencement of the shift.

c. Eye Reactions

The factors which contribute to eye symptoms in roofers were subjectively evaluated by use of the questionnaire previously described. The eye reactions were generally rated as being more severe for scratching and tear-off operations but of similar severity to the skin reactions for new roof installation. The relative weight given to the various environmental and roofing material factors was broadly similar for both organs. The mean scores obtained for each job classification as they influence the development and severity of eye symptoms from roofing operations are shown in Table VI. In scratching and tear-off operations the most severe eye symptoms are associated with power broom operation, hand sweeping and power scratching operations without a vacuum. The use of a vacuum was rated as leading to less symptomatology. In general, new roof installation was associated with less severe eye symptoms. Black roofers generally scored eye symptoms as less severe than whites although the scores they gave for eye symptoms were clearly greater than the scores they gave for skin irritation. The mean scores obtained from the questionnaire regarding the subjective assessment of the influence of various roofing materials and environmental factors on the development of eye symptoms are shown in Table VII. The environmental factors most strongly associated were sunlight and summer, less strong associations were with high humidity and windy days. Of the roofing materials pitch was the only material strongly linked with the occurrence of eye symptoms. Old style pitch was scored as being more irritating than the newer so-called 'no-burn' pitch, although the latter was still scored as causing significant symptoms. Using pitch at a high temperature was associated with more symptoms than using pitch just above the melting point.

A physical examination of the eyes of 17 roofers was performed at the commencement of or early in the shift. Signs of bilateral conjunctivitis were seen in 11 of these 17 roofers. The signs included increased lacrimation, chemosis, blepharospasm, lid swelling and blepharitis and conjunctival erythema. In a few employees erythema was more prominent in the lateral angles of the conjunctivae. Signs of conjunctivitis were seen in 8 of the 13 white and 3 of the 4 black roofers. Fourteen roofers were examined at the end of the shift, including eight of those

with conjunctivitis at the commencement of the shift. In two roofers conjunctivitis was no longer evident; conjunctivitis was still present in six roofers and signs of conjunctivitis were seen in two roofers whose eyes had appeared normal at the start of the shift.

One employee who had been off work for two days, reportedly because of severe eye symptoms was examined. Residual swelling of the eyelids and conjunctival erythema were observed, consistent with a diagnosis of conjunctivitis.

d. Correlation Between Results on Physical Examination and Airborne Exposure Measurements

Although the atmospheric exposures sustained by a particular worker are not necessarily similar from day to day and although to some extent visible skin changes may reflect cumulative exposures from previous days, some general indication as to the relationship between airborne contaminant levels and skin effects may be drawn from a correlation between the two on a particular day. Personal (breathing zone) filter samples for March 11, 1976, were available on thirteen employees whose skin had been examined on the same day. Four of these employees were black, in none of whom were changes apparent which were possibly attributable to pitch. Of the nine white roofers, six had skin erythema, each of whom had exposures of 0.18 mg/M^3 of PPOM or greater (range of 0.18-1.88 mg/M^3). Moreover, six of the 7 whites with exposures of 0.18 mg/M^3 PPOM or greater had evidence of dermatitis whereas neither of the two whites with lesser exposures (<0.01 mg/M^3 in each instance) had erythema. Using Fishers exact test there was no statistically significant correlation between environmental concentrations and erythema on examination on the day of the medical-environmental survey which may reflect the small number of employees for whom data was available.

The presence or absence of significant conjunctivitis on the day of examination was compared with the airborne PPOM concentration for the 13 employees for whom the data was available. Five of the 6 employees with exposures of 0.41 mg/M^3 PPOM or greater on March 11, 1976, and 7 of the 9 employees with exposures of 0.18 mg/M^3 PPOM or greater had conjunctivitis, contrasted with 0 out of 4 employees exposed to concentrations of 0.11 mg/M^3 or less. There was a statistically significant correlation at $P<0.05$ using Fishers exact test between the absence of conjunctivitis in workers exposed to concentrations of 0.11 mg/M^3 of PPOM or less and the presence of conjunctivitis in workers exposed to a PPOM concentration of 0.18 mg/M^3 or greater.

On March 11, 1976, there were eleven employees who were examined both before and after the shift for whom environmental exposure data was available. The degree of conjunctivitis had worsened in

3 of the 4 exposed to 0.41 mg/M^3 PPOM or greater, in 5 of the 7 roofers exposed to 0.18 mg/M^3 PPOM or greater and in none of the 4 roofers exposed to 0.11 mg/M^3 PPOM or less. These latter differences were not statistically significant.

The particular components of pitch responsible for the photosensitizing reactions were not identified, but several compounds theoretically capable of producing such reactions were identified in the bulk samples including anthracene, phenantrene, benz(a)anthracene, BaP and possibly others.

F. General Findings and Conclusions

1. There was an increased incidence of acute eye and skin disorders in this group of workers which appeared to be due to exposure to dusts containing coal tar pitch. The skin effects appear consistent with photosensitivity reactions induced by pitch dusts.

2. On both days when the environmental evaluations were undertaken, several roofers were exposed to airborne concentrations of PPOM in excess of the ACGIH recommended TLV of 0.2 mg/M^3. On March 11, 1976, when both the medical and environmental evaluations were undertaken, there was a statistically significant correlation between the presence of conjunctivitis in workers exposed to concentrations of 0.18 mg/M^3 of PPOM and the absence of conjunctivitis in workers exposed to concentrations of 0.11 mg/M^3 of PPOM or less.

3. The level of exposure to airborne materials in roofing operations is very variable and depends greatly on environmental factors such as wind, on operational conditions such as temperature and type of pitch, and particularly the use of water in wetting the surface areas prior to tear-off operations.

4. From the histories supplied by the roofers, the development of symptomatology appears related to variables other than just the chemical or pitch exposures. These include exposure to the sun, the humidity and season of the year. The type of roofing operation such as tear-off or scratching operation when an old roof is removed or of laying a new roof and the particular task worked within any operation influences the incidence and severity of reported eye and skin reactions. The most severe reactions especially in the eyes appear to be associated with tear-off operations as opposed to the installation of a new roof.[1]

5. Photosensitivity reactions from pitch such as the skin reactions in roofers depend for their development both on exposure to certain components of pitch and ultraviolet radiation (wavelengths between 320 nm and 400 nm) such as that present in sunlight. The reactions

may, therefore, be eliminated by protecting either against pitch or against ultraviolet radiation. This is the reason that these reactions are less in the winter and on cloudy days when ultraviolet radiation from the sun is reduced. In order to protect against these wavelengths from sunlight, workers should shield themselves from sunlight with clothing and should keep out of direct sunlight as much as possible. The majority of commercially available sunscreens do not protect against the portions of sunlight responsible for these reactions, but there are a few preparations available which may be of use. It is important to realize that repeated and prolonged episodes of skin photosensitivity reactions may increase the danger of developing more serious acute and chronic skin and eye diseases.

6. Blacks appear to show relative resistance to the acute skin photosensitizing effects of coal tar pitch volatiles and dust, presumably as a result of their degree of pigmentation. They appear to be less, if at all, protected against the development of conjunctivitis from these substances.

7. Although this survey characterized some qualitative and quantitative data within current constraints, further development is necessary concerning sampling and analytical methodology to more fully qualitate and quantitate the exposures of roofers under field conditions.

8. BaP is a well-known carcinogen as well as a contaminant in most bulk pitch samples including the bulk samples obtained in this evaluation. The actual concentration of BaP was not determined in the airborne samples and, therefore, the results cannot be directly compared to the recommendations of the Standard Advisory Committee on Coke Oven Emissions that employees not be exposed to BaP in excess of 0.0002 mg/M^3 on an eight-hour time-weighted average. Based on the values obtained for BaP plus BeP in personal breathing zone samples, it appears possible that exposure to BaP in tear-off operations could considerably exceed the recommended level for coke oven workers, particularly since BaP is present in the bulk samples. In order to further evaluate the possibility that BaP is present in hazardous amounts in roofing operations, it would be necessary to not only qualitate BaP in the bulk samples, but also to qualitate and quantitate the concentration of BaP present in airborne contaminants at the worksite.

G. Recommendations

In view of the above findings, the following recommendations are made. It should be noted that these recommendations are designed for the prevention of acute skin and eye conditions and are not based on a

thorough evaluation of chronic conditions which may occur in roofers. The recommendations are applicable to exposure of workers to coal tar pitch dusts or vapors generated during tear-off operations covered by this evaluation and/or a previous evaluation.[1]

1. Good personal hygiene is of prime importance. Employees should shower and wash thoroughly with soap and water at the end of a shift. Attention should be given to flushing of the eyes with water at these times. A complete change of clothing should be made after showering.

2. Freshly laundered work clothes should be worn daily.

3. Skin contaminated with pitch dusts, fumes or molten pitch should be washed promptly with soap and water or a waterless cleaner.

4. Skin should be protected from pitch dusts, vapors, and sunlight as much as possible. Long sleeve shirts, buttoned cuffs, cuffless full-length pants that cover the tops of his shoes, work shoes that are ankle high and gloves that have no gauntlets or cuffs and are tight at the wrists should be used at all times. Head and neck protection could be afforded by wearing a cape to prevent pitch dust from falling onto the hair and down the back of the neck. These short head-neck capes and other clothing would also offer some protection from sunlight.

5. An attempt could be made whenever possible to reduce exposure to summer sunlight during the hours when ultraviolet radiation from the sun is most intense. During summer when daylight savings is in effect this would be between 11 a.m. and 3 p.m.

6. The phototoxic skin reactions from pitch are attributable to longer ultraviolet radiations than those which normally produce sun burn. Most commercial sunscreen preparations are ineffective against these radiations. The best sunscreen to prevent phototoxic reactions for pitch are unknown. Some which one might expect to be effective include those containing an opaque screen such as zinc oxide paste or titanium dioxide or those containing benzophenones. An example of a combination of both types of agent is solar cream® (Doak Pharmaceuticals). UVAL® (Dome Laboratories) and solbar® (Person & Covey, Inc.) both contain benzophenone.

7. Every effort should be made to avoid exposure to pitch dusts and fumes. These measures should include:

   a. All employees should stay upwind of pitch dusts and fumes at all possible times;

   b. Crews should avoid working downwind of another crew unless exposure to pitch dusts and fumes is not occurring;

c. Kettles, tanks, and/or dumping operations should be downwind from roofing operations;

d. Equipment in which hot pitch is stored or transported should be closed whenever possible.

8. The working temperature of the pitch should be kept as low as possible. Devices should be provided to ensure appropriate temperatures either automatically or by employee control. Such devices include thermostatically controlled tanks or kettles, thermometers or other temperature sensitive devices.

9. Medical surveillance should be made available to all roofers repeatedly exposed to operations where coal tar pitch is used. This should include an annual medical examination including interval medical and occupational exposure histories and a complete physical examination including examination of the skin and eyes.

10. Periodic personnel monitoring should be conducted in such a manner to determine that every employee's exposure is below the prescribed limits for PPOM for those workers exposed to dusts or vapors from hot or cold coal tar pitch. Samples should be collected from the breathing zones of employees when determining the employee's exposure to PPOM.

11. Employees who may be or are exposed to 0.2 mg/M^3 of PPOM, or above, shall wear respirators which are approved by NIOSH under the provisions of 30 CFR Part 11. The employer shall select and provide the appropriate respirator from the list below and shall assure that the employee uses the respirator provided.

    a. Air-purifying respirator equipped with high efficiency particulate filter.*

    b. Powered air-purifying respirator equipped with high efficiency particulate filter.*

    c. Type C, positive pressure supplied-air respirators.

    *High efficiency particulate filter means 99.97 percent efficient against 0.2 micron particles.

    Respirators shall be used and maintained in accordance with Section 1910.134 of Subpart I - "Personal Protective Equipment",, Title 29, CFR, Chapter XVII.

    Personal protective equipment should not be utilized in lieu of improved administrative and engineering controls (e.g., periodic or daily rotation of employees from tasks or jobs involving high exposure to jobs involving less exposure; use of water to dampen and thoroughly wet surface areas; use of large vacuum cleaner, etc.).

12. Employees who may be or are exposed to 0.2 mg/M^3 or greater of PPOM shall wear safety goggles in order to prevent coal tar pitch dusts from entering the eyes.

13. Water should be used to thoroughly wet and dampen the surface of the roof prior to and during tear-off operations. Piles of accumulated debris on the roof or ground should be routinely wetted down to prevent the generation of airborne dust.

14. The current method of cleaning the filter from the power vacuum cleaner with compressed air generates an undue amount of fine airborne dust and should be discontinued. Consideration should be given to cleaning the filter in a confined area or enclosure with appropriate ventilation or by other means such as vacuuming the filter and/or washing the filter with high pressure water jets to minimize dust exposure.

V. REFERENCES

1. Health Hazard Evaluation Determination Report No. 75-102-304.

2. Sawicke, E.; T.R. Hauser and T.W. Stanky; Int. J. Air Pollution, 2, 253 (1960).

3. Memorandum dated February 18, 1976, from Barry R. Belinky and Robert L. Larkin, Analytical Services Section; NIOSH, Cincinnati, Ohio.

4. Haenni, E.O. and M.A. Hall, I.A.O.A.C., 43 (1), 92 (1960).

5. Lao, R.C., R.S. Thomas, H. Oja and L. Dubois; Anal. Chem., 45 (6), 908 (1973).

6. NIOSH Manual of Analytical Methods; HEW Publication No. (NIOSH) 75-121.

7. Sawicke, E.: Testimony given before the OSHA Standards Adivsory Committee on Coke Oven Emissions; February 12, 1975, Washington, D.C.

8. Whitman, N.E.: Testimony given before the OSHA Standards Advisory Committee on Coke Oven Emissions; January 30, 1975, Washington, D.C.

9. Bumstead, H.E.: Testimony given before the OSHA Standards Adivsory Committee on Coke Oven Emissions; March 4, 1975, Washington, D.C.

10. Proposed Standards for Exposure to Coke Oven Emissions, Volume 40, Number 148, Part III, July 1975.

11. "Determination of Pitch Volatiles in Airborne Particulate"; H.J. Seim, W.W. Hanneman, L.R Barsotti and T.J. Walker; Kaiser Aluminum and Chemical Corporation Center for Technology, Pleasanton, California.

12. Documentation of the Threshold Limit Values for Substances in Workroom Air, ACGIH, 1975.

13. Cavalie, B. and Duprè, A.: Les dermites de photosensibilisation chez les repandeurs de liants routiers. Arch Maladies Professionelles. 15: 132-134, 1954.

14. Hammond, E.C., Selikoff, I.J. and Lawther, P.J.: Inhalation of Benzpyrene and Cancer in Man. Presented at American College of Chest Physicians, Chicago, Illinois. 1969.

15. Hammond, E.C.; Selikoff, I.J.; and Lawther, P.J.: Inhalation of benzpyrene and cancer in man in Annals N.Y. Acad. Sci. 271: 116-124, 1976.

16. Emmett, E.A.: Ultraviolet radiation as a cause of skin cancer. Crit. Rev. Tox. 2: 211-255, 1973.

17. Emmett, E.A.: Occupational Skin Cancer: A Review. J. Occupat. Med. 17: 44-49, 1975.

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TABLE I

ENVIRONMENTAL RESULTS OF BREATHING ZONE (PERSONAL) AND GENERAL AREA FILTER SAMPLES (GLASS FIBER-SILVER MEMBRANE PLUS BACKUP PAD) OBTAINED DURING TEAR-OFF ROOFING OPERATIONS ON AN OLD ROOF OF A SEVEN ACRE FACILITY AT LAKE CITY, MISSOURI, ON MARCH 10, 1976,* AND ON MARCH 11, 1976. (ALL SAMPLE RESULTS ARE EXPRESSED AS MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED--mg/M^3). RIE 75-194

JOB DESCRIPTION OR LOCATION	TIME AM	TIME PM	SAMPLE NUMBER[a]	SAMPLE VOLUME LITERS	DUST OR PARTICULATE MATTER[b]-mg/M^3	PARTICULATE POLYCYCLIC ORGANIC MATTER (PPOM)[c] as CYCLOHEXANE SOLUBLES mg/M^3	RANGE OF POLYNUCLEAR AROMATIC HYDROCARBONS (PNA)[d] mg/M^3	BENZO(a)PYRENE (BaP) plus BENZO(e)PYRENE (BeP)[e]-mg/M^3
Power Broom Operator*	8:45	3:40	A-2-T	705	1.7	0.28	.018-.085	.009
			SG-1	15				
Scratching Machine Operator*	8:56	3:38	A-6-T	683	2.8	0.38	.034-.140	.009
			CT-1	14				
Scratching Machine Operator*	9:10	3:41	A-9-T	664	2.6	0.73	.045-.193	.018
			SG-4	22				
Utility Operator*	8:50	3:50	A-4-T	714	0.2	0.15	.003-.021	<.002
			SG-2	19				
Power Broom Machine Operator #1	7:50	1:55	F-19-T(CT-24)	547	0.4	0.20	.009-.047	<.002
			F-20-T(SG-29)	438	0.5	<0.01	.011-.057	<.002
			CT-8	16				
Power Broom Machine Operator #2	7:50	2:02	F-6-T(CT-21)	409	0.5	0.33	.015-.071	.005
			F-5-R	632	0.1	<0.01	.003-.022	<.002
			SG-22	11				
Scratching Machine Operator #1	8:05	1:58	F-9-T(SG-24)	565	2.2	0.48	.011-.053	.002
			F-10-R	600	0.5	0.17	.001-.015	<.002
			CT-6	14				
Scratching Machine Operator #2	7:57	1:56	F-3-T(SG-21)	467	1.3	0.24	.021-.096	<.002
			F-4-R	544	0.2	0.19	.004-.026	.004
			CT-4	17				
Power Vacuuming Machine Operator #1	8:12	2:22	F-31-T(SG-35)	592	5.9	0.72	.059-.247	.014
			F-32-R	629	0.4	0.08	.010-.046	.002
			CT-12	14				

JOB DESCRIPTION OR LOCATION	TIME AM	TIME PM	SAMPLE NUMBER	SAMPLE VOLUME LITERS	DUST OR PARTICULATE MATTER[b]-mg/M^3	PARTICULATE POLYCYCLIC ORGANIC MATTER (PPOM)[c] as CYCLOHEXANE SOLUBLES mg/M^3	RANGE OF POLYNUCLEAR AROMATIC HYDROCARBONS (PNA)[d] mg/M^3	BENZO(a)PYRENE (BaP) plus BENZO(e)PYRENE (BeP)[e]-mg/M^3
Power Vacuuming Machine Operator #2	7:55	2:17	F-7-T(SG-23) CT-5	613 17	1.2	1.88	.013-.059	.010
Hot Pitch Patching-Flashing Operator #1	7:57	1:50	F-2-T(SG-20) CT-3	459 15	1.4	1.60	.028-.129	.011
Hot Pitch Patching-Flashing Operator #2	8:01	2:06	F-23-T(SG-31) CT-10	511 20	1.8	<0.01	.008-.047	.004
Utility Operator #1	8:07	1:59	F-12-R SG-25	598 19	0.3	<0.01	<.001-.012	<.002
Utility Operator #2	7:59	2:02	F-21-T(SG-30) F-22-R CT-9	544 617 13	1.8 0.2	0.07 0.02	.017-.075 .003-.023	.003 .002
Utility Operator #3	8:03	1:58	F-25-T F-26-R SG-32	461 603 13	1.1 0.1	1.13 0.15	.009-.050 <.001-.008	<.002 <.002
Utility Operator #4	8:07	2:04	F-27-T(SG-33) CT-11	464 13	1.7	0.41	.022-.099	.006
Utility Operator #5	8:15	2:00	F-14-T(SG-26) CT-7	480 17	1.5	0.11	.010-.056	<.002
Utility Operator (Some Wetting Down) #6	8:10	2:00	F-34-T(SG-36) CT-13	560 14	0.9	0.18	.007-.039	.007
Front End Loader & Truck Driver #1	10:00	2:10	F-35-T(SG-37) F-36-T(CT-26)	400 325	1.9 1.8	0.08 0.12	.020-.100 .018-.089	.005 .005

JOB DESCRIPTION OR LOCATION	TIME AM	TIME PM	SAMPLE NUMBER	SAMPLE VOLUME LITERS	DUST OR PARTICULATE MATTER[b]-mg/M^3	PARTICULATE POLYCYCLIC ORGANIC MATTER (PPOM)[c] as CYCLOHEXANE SOLUBLES mg/M^3	RANGE OF POLYNUCLEAR AROMATIC HYDROCARBONS (PNA)[d] mg/M^3	BENZO(a)PYRENE (BaP) plus BENZO(e)PYRENE (BeP)[e]-mg/M^3
General Area - Work Horse	8:55	2:06	F-17-T(SG-28)	404	3.7	1.22	.024-.128	.007
			F-18-T(CT-23)	466	4.9	0.62	.015-.088	.019

a. T=Total dust or particulate; R=Respirable dust or particulate. Also, CT or SG in parenthesis after filter sample number shows that a charcoal tube or a silica gel tube, respectively, followed the filter in series to also obtain a high volume CT or SGT sample; e.g., F-35(SG-37) shows that filter sample number 35 was followed in series by a silica gel tube sample number 37. Low volume CT or SGT samples were obtained with no pre-filters. Refer to text of report for results of CT and SGT samples.

b. The American Conference of Governmental Industrial Hygienists (ACGIH) recommended Threshold Limit Value (TLV) for total nuisance dust or particulates is 10 mg/M^3 and for respirable nuisance dust or particulates is 5 mg/M^3. It is noted that coal tar pitch dust is not considered as nuisance dust.

c. The ACGIH recommended TLV for PPOM as benzene solubles is 0.2 mg/M^3. The difference between benzene solubles and cyclohexane solubles is insignificant and for the most practical purposes are considered the same.

d. There are no ACGIH recommended TLV's or Federal Occupational Health Standards for PNA.

e. There are no ACGIH recommended TLV's or Federal Health Standards for BaP or BeP. However, BaP is a known carcinogen and the Standard Advisory Committee on Coke Oven Emissions recommended that employees not be exposed to BaP in excess of 0.002 mg/M^3 of BaP on an eight-hour time-weighted average. Analysis of samples does not differentiate between BaP or BeP.

TABLE II

RESULTS FROM THREE HIGH VOLUME CHARCOAL TUBE SAMPLES OBTAINED DURING TEAR-OFF ROOFING OPERATIONS ON AN OLD SEVEN (7) ACRE FACILITY AT LAKE CITY, MISSOURI ON MARCH 11, 1976. (ALL SAMPLE RESULTS ARE EXPRESSED AS MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR - mg/M^3). RHE 75-194

JOB DESCRIPTION	TIME AM PM	SAMPLE NUMBER	SAMPLE VOLUME LITERS	ALIPHATIC HYDROCARBONS TOTAL mg/M^3	ALIPHATIC HYDROCARBONS HIGHEST SINGLE COMPONENT mg/M^3	BENZENE mg/M^3	TOLUENE mg/M^3	XYLENE mg/M^3
General Area - Work Horse	8:55-2:06	CT-23 (preceded by filter sample No. F-18-T)	466	15.0	1.5	0.6-1.1	0.4-0.9	1.3-1.7
Utility Operator #3	8:03-1:58	CT-25 (preceded by filter sample No. F-25-T)	461	3.5	0.2	0.1-0.2	0.1-0.2	0.2
Front End Loader & Truck Driver	10:00-2:10	CT-26 (preceded by filter sample No. F-36-T)	325	2.5	0.6	<0.15	<0.15	<0.15

NOTE: CT-23 had the highest concentration and mass spectrometry work was performed on this sample. The highest components were identified as aliphatic hydrocarbons such as substituted pentanes, dodecanes, octanes, etc., in the C_5-C_{12} range. Benzene, toluene, xylene and trace amounts of other substituted benzenes were also detected. No PNA's or other higher boiling compounds were indicated. However, PNA's would probably not be desorbed from the charcoal and, therefore, not detected by this analytical method. No concentration of any single compound was found to be exceptionally high on any of the tubes. No attempt was made to qualitate and quantitate (other than shown above) each component due to the multiplicity of peaks.

TABLE III

RESULTS FROM TWO BULK SAMPLES OBTAINED DURING TEAR-OFF ROOFING OPERATIONS AT LAKE CITY, MISSOURI
RHE 75-194

COMPOUND	OLD DUST BULK PERCENT (%) BY WEIGHT	NEW HOT PITCH BULK PERCENT (%) BY WEIGHT
Anthracene and/or phenantrene	1.2	3.4
Fluoranthene	1.2	2.8
Pyrene	0.8	2.0
Chrysene and Benz (a) anthracene	0.8	1.6
Benzo(k)fluroanthene	0.7	1.2
BaP plus BeP	0.4	1.0

TABLE IV

Subjective Assessment of the Influence of Job Classifications on the Development of Symptoms on Exposed Skin Areas from Roofing Operations. RHE 75-194

Job Classification	White Employees		Black Employees		All Employees	
	No. of Respondents	Mean Score*	No. of Respondents	Mean Score	No. of Respondents	Mean Score
Scratch and Tear Off Oper.						
Power Broom Operator	11	2.6	4	0	15	1.9
Clean Off Crew	11	2.5	4	0.25	15	1.9
Sweeper	11	2.4	4	0	15	1.8
Power Scratching Machine Operator	10	2.2	4	0	14	1.6
Hand Scratching Operator	11	1.6	4	0	15	1.2
Tractor Operator	11	1.5	4	0	15	1.1
Cutting Machine Operator	10	1.2	4	0	14	0.9
Aggregate Scratching and Tear off Operation	75	2.0	28	0.04	103	1.5
New Roof Installation						
Hot carrier-pitch	11	1.8	4	0	15	1.3
Hot packer	11	1.5	4	0	15	1.1
Pitch and Gravel Spreader	10	1.3	4	0	14	0.9
Felt Machine Operator	9	1.0	4	0	13	0.7
Broom Man	10	0.9	4	0	14	0.6
Insulation Crew	11	0.7	4	0	15	0.5
Header and Flashing Crew	11	0.5	4	0	15	0.4
Hot carrier-asphalt	11	0.4	4	0	15	0.3
Aggregate New Roof Installation	84	1.0	32	0	116	0.7
Aggregate all Job Classification	159	1.5	60	0.02	219	1.1

*Each employee rated each job classification as causing
Very bad skin problems - associated with the development of most severe symptoms-- - Score of 5
Bad skin problems - often associated with severe symptoms---- Score of 3
Occasional skin problems - occasional discomfort or symptoms---- Score of 1
No skin problems - Score of 0

TABLE V

Subjective Assessment of the Influence of Roofing Materials and Environmental Factors on the Development of Skin Irritation on Exposed Areas of the Skin From Roofing Operations. RHE 75-194

Environmental Factors	White Employees		Black Employees		All Employees	
	No. of Respondents	Mean Score*	No. of Respondents	Mean Score	No. of Respondents	Mean Score
Summer	11	2.7	4	0.25	15	2.0
Windy day	11	2.7	4	0	15	2.0
Sunny day	11	2.5	4	0.25	15	1.9
Very humid	11	2.3	4	0	15	1.7
Still day	11	1.8	4	0	15	1.3
Not humid	11	1.3	4	0	15	1.0
Winter	11	1.0	4	0	15	0.7
Cloudy day	11	1.0	4	0	15	0.7
Roofing Materials						
Old style pitch	10	2.6	4	0	14	1.9
New 'No-burn' Pitch	11	1.2	4	0	15	0.8
Insulation	11	1.0	4	0	15	0.7
Gravel	11	0.1	4	0	15	0.1
Felt	11	0.1	4	0	15	0.1
Asphalt	11	0.1	4	0	15	0.1
Pitch hot(about 500°F)	11	2.5	4	0	15	1.8
Pitch not very hot	11	1.6	4	0	15	1.2
Aggregate Environmental Factors & Roofing Materials	173	1.5	64	0.03	238	1.1

*Each employee rated each environmental factor and roofing material as causing
Very bad skin problems - associated with the development of most severe symptoms- Score of 5
Bad skin problems - often associated with severe symptoms— - Score of 3
Occasional skin problems - occasional discomfort or symptoms— - Score of 1
No skin problems - Score of 0

TABLE VI

Subjective Assessment of the Influrence of Job Classification on the Development of Eye Symptoms from Roofing Operations. RHE 75-194

Job Classification	White Employees No. of Respondents	White Employees Mean Score*	Black Employees No. of Respondents	Black Employees Mean Score	All Employees No. of Respondents	All Employees Mean Score
Scratch & Tear Off Operations						
Power Broom Operator	11	3.9	3	1.0	14	3.3
Sweeper	11	3.7	4	2.0	15	3.2
Power Scratcher Operator without vacuum	11	2.8	4	1.0	15	2.3
Clean Off Crew	11	2.8	4	1.0	15	2.3
Power Scratcher Operator with vacuum	9	2.4	3	1.0	12	2.0
Hand Scratcher	11	2.3	4	0	15	1.7
Tractor Operator	8	1.7	4	0	12	1.1
Cutting Machine Operator	9	1.3	3	1.0	12	1.2
Aggregate Scratching and Tear Off Operations	81	3.0	29	0.9	110	2.4
New Roof Installation						
Hot Packer	11	1.6	4	0	15	1.2
Hot Carrier-Pitch	10	1.5	4	0	14	1.1
Pitch Gravel Spreader	11	1.2	4	0	15	0.9
Insulation Crew	10	1.1	4	0	14	0.8
Broom Man	10	0.8	3	0	13	0.6
Felt Machine Operator	9	0.6	4	0.25	13	0.5
Header & Flashing Crew	10	0.5	4	0	14	0.4
Hot Carrier-Asphalt	11	0	4	0	15	0
Aggregate New Roof Installation	82	0.9	31	0.03	113	0.7
Aggregate All Job Classifications	163	1.9	60	0.4	233	1.5

*Each employee rated each job classification as causing:
Very bad eye problems-associated with the development of most severe symptoms---- Score of 5
Bad eye problems-often associated with severe symptoms---- Score of 3
Occasional eye problems- occasional discomfort or symptoms---- Score of 1
No eye problems- Score of 0

TABLE VII

Subjective Assessment of the Influence of Roofing Materials and Environmental Factors on the Development of Eye Symptoms from Roofing Operations. RHE 75-194

	White Employees		Black Employees		All Employees	
Environmental Factors	No. of Respondents	Mean Score*	No. of Respondents	Mean Score	No.of Respondents	Mean Score
Sunny day	11	3.9	4	2.25	15	3.5
Summer	11	3.7	4	1.25	15	3.0
Very humid	11	2.8	4	1.0	15	2.3
Windy day	11	2.9	4	1.0	15	2.1
Still day	10	2.0	4	0.5	14	1.6
Not humid	11	1.4	4	0.25	15	1.1
Winter	11	1.1	4	0.25	15	0.9
Cloudy day	11	0.9	4	0.25	15	0.7
Roofing Materials						
Old Style Pitch	9	3.4	3	0.3	12	2.6
New 'No-Burn' Pitch	9	2.2	3	0.3	12	1.7
Insulation	11	0.5	4	0	15	0.3
Asphalt	10	0.1	4	0	14	0.1
Gravel	11	0.2	4	0	15	0.1
Felt	11	0.1	4	0	15	0.1
Pitch Hot(about 500°F)	10	3.6	4	1.0	14	2.9
Pitch not very hot	10	2.1	4	0.25	14	1.6
Aggregate Environmental Factors & Roofing Materials	168	1.9	62	0.5	230	1.5

*Each employee rated each environmental factor and roofing material as causing:
Very bad eye problems- associated with the development of most severe symptoms - Score of 5
Bad eye problems- associated with severe symptoms---- Score of 3
Occasional eye problems- occasional discomfort or symptoms--- Score of 1
No eye problems - Score of 0