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. 75-102-304

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

JUNE 1976

I. TOXICITY DETERMINATION

It has been determined that employees were exposed to potentially toxic concentrations of particulate polycyclic organic matter (PPOM) as cyclohexane solubles which includes polynuclear aromatic hydrocarbons (PAH) during roofing operations involving the installation of a new roof on a forty-six (46) acre warehouse in Lenexa, Kansas. This determination is based on data collected during roofing operations involving the use of asphalt and coal tar pitch during the medical-environmental survey at Lenexa on September 4, 1975, which included: (a) medical interviews and limited physical examinations; (b) environmental measurements for PPOM; and (c) a review of available literature on PPOM.

Sixty-nine percent of examined roofers working on this project gave a history of apparent skin photosensitivity attributed to pitch exposures occurring during this project. Fifty percent of the examined roofers also complained of conjunctival symptoms which they also related to pitch exposures. On the day of this evaluation, 18 percent of examined workers were observed to have conjunctivitis of a moderate or mild degree, 18 percent evidence of photosensitization reactions to localized areas of the skin and 15 percent of relatively generalized erythema in the exposed areas. In the latter instances, the role of sun exposure alone and/or pitch photosensitization could not be separated. There was a statistically significant ($P<0.05$) correlation between exposure to airborne PPOM at a concentration of greater than 0.2 mg/M^3 on the day of the evaluation and the presence of conjunctivitis on examination. A number of chronic skin and eye conditions were noted in examined workers but it could not be determined if their occurrence was excessive. A total of thirty-eight (38) personal air samples were obtained on 26 employees and varied from less than 0.02 mg/M^3 to a maximum of 0.49 mg/M^3 of PPOM which includes PAH. Environmental results show that six 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.

There was no particular evidence from either the environmental or medical results of this study to believe that fibrous glass or asphalt made an important contribution to the acute skin and eye problems sustained by the roofers. All environmental results were less than 40 percent of the ACGIH recommended TLVs of 5 mg/M^3 and 10 mg/M^3 for asphalt and fibrous glass respectively. Based on this limited evaluation, no definitive statements can be made concerning the presence of carcinogens or co-carcinogens in the work atmosphere or their effects on the workers.

Detailed information concerning the results of the medical-environmental survey conducted on September 4, 1975, and a follow-up environmental survey on September 18, 1975, 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) Sellers and Marquis Roofing Company, A.J. Shirk Roofing Company, Western 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 thirty-five (35) 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 contaminants, particularly coal tar pitch volatiles (CTPV), (which is the same as particulate polycyclic organic matter-PPOM), during roofing operations involving asphalt and coal tar pitch. 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 roofing operations.

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 which are consolidated for business purposes to engage in the installation of new roofs for new commercial construction and non-residential construction. The area of concern involved the installation of a flat roof on a metal deck of a 46 acre warehouse located in Lenexa, Kansas. Operations involved the application of hot asphalt to the metal deck to provide adhesion and a seal for the first layer of insulation (1 1/8" bonded fiber glass). Asphalt is added to the first layer of insulation and then a second layer of fibrous glass insulation is added. Hot pitch is added to provide a seal and adhesion to the first layer of felt which is laid over the insulation. This process is repeated until four layers of pitch-felt are laid over the insulation. The last operation involves the addition of pitch and gravel to provide a half inch of pitch-gravel over the felt and insulation layers. The coal tar pitch is heated and applied at approximately 375°F to 400°F. Asphalt is heated and applied at approximately 480°F. Employee exposure is from the volatile matter emanating from the heated asphalt and coal tar pitch during the various roofing operations. Approximately 30,000 to 40,000 square feet of new roof can be installed in one day with a crew of 30 employees.

B. Study Progress

An initial walk-through survey was conducted on July 3, 1975. It was determined that a comprehensive environmental and medical evaluation was necessary. The comprehensive medical-environmental study was carried out on September 4, 1975. Some further environmental data was obtained on September 18, 1975, under slightly different environmental circumstances. The temperature on September 4, 1975, varied from approximately 71°F to 85°F (average 71°F) and the relative humidity varied from 50 to 80 percent. Winds were very gusty at approximately 15 miles per hour to 20 miles per hour from the north. The temperature on September 18, 1975, varied from approximately 64°F to 78°F (average 72°F) and the relative humidity was estimated at 75 percent. Winds were calm, with some wind estimated at 5 miles per hour from the south and north. Both days were partly cloudy.

The vapors emanating from the hot asphalt and pitch were immediately dispersed by the gusty winds on September 4, 1975, but were not as readily dispersed on September 18, 1975.

All employees are generally exposed to a low level vapor from both the hot asphalt and hot pitch as both are used in the same general work area. However, it is noted that the three gravel-pitch machine operators were not working in the same general area of the roof as the rest of the crew on September 4, 1975. There are different types of coal tar pitch with a recent variety being of a less volatile "no burn" type which gives off less volatiles or fumes at operating temperatures. The "no burn" type of pitch was used during this study and this type of pitch still produces fumes and produces burns although perhaps to a lesser extent according to those in the trade.

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 they may be considered as eight-hour time-weighted averages. Most employees wore two to three sampling apparatuses. General area samples were attached to the handles of the felt pitch machine and were attached under the operators seat of the gravel pitch machine. The results from the area samples were located a few feet from source of emissions, and hence, cannot be considered as the exposure levels of the workers.

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. A few respirable particulate samples were also obtained using a 10 mm cyclone. All samples were analyzed gravimetrically for total particulates. All samples obtained were also analyzed for PPOM (as cyclohexane solubles) by using ultrasonic extraction (Sawicke's method)[1] and gravimetric (Cahn electrobalance) techniques. PPOM has been previously determined by a modification of a method employed by Haenni and Hall[2] for the determination of aromatic content of mineral oil. Lao[3] had identified more than 100 polycyclic aromatic hydrocarbons (PAH) and determined that many of the higher molecular weight PAH's are not usually identified because of analytical limitations. PAH levels were analyzed by a new method[4] developed by NIOSH laboratories which is more specific for the higher molecular weight polycyclic aromatic hydrocarbons. Only the minimum amount and the maximum amount or the range of PAH is reported by this new method. In addition to analysis for PPOM and PAH on all samples, analysis was made for benzo(a)pyrene (BaP) or benzo(e)pyrene (BeP) utilizing gas chromatography with flame ionization detection.[4]

Alpha or beta naphthylamine samples were collected with silica gel tubes in line with a low flow Sipin pump at a rate of approximately 0.050 lpm. Organic vapor samples were collected with charcoal tubes in a similar manner. These samples were analyzed by gas chromatography (PACAM 127)[5] for organics and alpha or beta naphthylamine.

Exposure to vapors from hot coal tar pitch and asphalt has been previously studied in the past. Many of these studies have analyzed environmental samples for coal tar pitch volatiles (CTPV) which includes only the benzene soluble portion of the particulates collected and separately for benzo(a) pyrene (BaP). For purposes of this report, PPOM (as cyclohexane solubles) is considered equivalent to CTPV or PPOM (as benzene solubles). The method used in this study involved cyclohexane extraction. It is also noted that benzene as well as cyclohexane also dissolves some aliphatic hydrocarbons as well as 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.[6,7,8,9] In some of the previous studies, analysis was made of only the glass fiber-silver membrane filters and the backup pad was discarded. However, a recent study by H.J. Seim[10] et al, showed that the backup pad also had significant amounts of PPOM which indicates that analysis should at least include the backup filter. Hence, filters and backup pad for each sample were analyzed either separately or together to obtain the total PPOM.

2. Medical Methods

Thirty-four employees were questioned and examined. Informed consent was obtained from each worker. A brief questionnaire was then completed containing identification data. A detailed occupational history and a medical history of complaints related to work was obtained by one of the physicians. Workers were specifically asked about skin, eye and other complaints. Skin, eye and other symptoms were elicited both for the current roofing operation and for previous experience while roofing. In particular, the circumstances under which skin and eye symptoms occurred was elicited from each worker. A physical examination of the skin and eyes of each worker was obtained. Photographs of representative work conditions and of skin lesions in a small number of workers were obtained. All employees (total 34) including management of the company were evaluated.

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 Part 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
Particulate polycyclic organic matter (PPOM) as benzene solubles	0.2 mg/M^3* (This limit is the same for the Federal Occupational Health Standard).
Asphalt (petroleum) fumes	5.0 mg/M^3*
Glass fibrous or dust (7 microns in diameter)	10.0 mg/M^3*
Alpha or Beta napthylamine**	----------
Benzo(a)pyrene*** - skin (BaP)	----------

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

** 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 1910.93) for the protection of workers involved in the manufacture, processing, release, handling, or storage 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. 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 0.0002 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 PAH. Use of any 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 eye as a result of the roofing operation were evaluated. It is known that roofers suffer from photosensitization reactions on the skin as a result of exposure to pitch, (ref. Crow, 1971[12]). 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 (Hammond[13] et al). On the other hand, roofers could be exposed to a number of materials which are suspected of being carcinogenic such as BaP from coal tar pitch and potentially to other materials which are cocarcinogens.

E. Evaluation Results and Discussions

1. Environmental Results and Discussions

a. Results of Filter Samples Obtained for Total and Respirable Particulate, PPOM, PAH and BaP.

A total of thirty-eight (38) personal air samples (26 for total particulate and 12 for respirable particulate) were obtained on September 4, 1975, and 7 personal air samples (total particulate) were obtained on September 18, 1975. The results of these dust samples were too varied to make any definitive statements on total vs. respirable dusts. All results were less than 2 mg/M^3 which is considerably less than the ACGIH recommended TLV of 5 mg/M^3 for asphalt fumes, or the TLV of 10 mg/M^3 for fibrous glass or dust.

Tables I and II present all the sample results for PPOM and PAH for the surveys conducted on September 4, 1975, and September 18, 1975, respectively. A total of thirty-eight (38) personal air samples (includes 12 respirable samples) were obtained on 26 employees during the first survey. The level of PPOM detected in these personal samples varied from less than 0.02 mg/M^3 to a maximum of 0.49 mg/M^3 (average of approximately 0.10 mg/M^3) for PPOM. Of these samples, results showed that six employees (i.e., hoisting engineer, gravel-pitch machine operator B and operator C, felt-pitch machine operator B, broom operator B and support operator B) were exposed to concentrations exceeding the ACGIH recommended TLV of 0.20 mg/M^3 for PPOM. Seven personal air samples on seven employees were obtained on September 18, 1975, and levels ranged from less than 0.03 mg/M^3 to 0.53 mg/M^3 for PPOM. Three of these employees (i.e., gravel-pitch machine operator A, broom operator A and broom operator B) were exposed to concentrations exceeding the ACGIH recommended TLV of 0.20 mg/M^3 for PPOM. The results of the area samples, although not considered as exposure levels, ranged from 0.04 to 2.38 mg/M^3 of PPOM. Analytical measurements were made on the filters together and the

backup pad separately on some samples. These sample results indicate that a significant amount of approximately 10 to 80 percent of PPOM was passing through the filters and being absorbed on the backup pad. It may be possible that some organic matter may even pass through the backup pad.

Tables I and II also present the sample results for the range of minimum to maximum concentrations of PAH which may be expected for these samples. There are no ACGIH recommended TLV or other Federal Occupational Health Standards for PAH. Sample results do show employee exposure to PAH and also show some PAH passed through the filters and absorbed on the backup pad. It is also possible that PAH passes through the backup pad.

All personal and general area air samples were also analyzed for BaP or BeP as these compounds cannot be separated under laboratory condition used in the determination. No BaP or BeP was detected in any of the air samples obtained on both surveys at a level of detection of 0.030 mg of BaP or BeP per sample. Better sensitivity is necessary concerning the sampling and particularly the analytical techniques before any definitive statement can be made concerning BaP or BeP concentrations and any associated hazards to the worker.

Bulk pitch and asphalt samples were also analyzed for PPOM, BaP-BeP and PAH. The following results were reported:

Pitch - 4.89 percent by weight PPOM as cyclohexane solubles; 1.9 to 13 percent of cyclohexane solubles (PPOM) are PAH; and 270 ppm of BaP and/or BeP in the bulk pitch.

Asphalt - 10.3 percent by weight PPOM as cyclohexane solubles; 0.5 to 3.2 percent of cyclohexane solubles (PPOM) are PAH; and the bulk asphalt had not detected BaP and/or BeP (less than 6 ppm).

There appears to be a significant difference in composition of pitch and asphalt with the more higher molecular weight PPOM and PAH as well as BaP or BeP present in the pitch.

b. Results of Silica Gel Tube Samples for Alpha or Beta Naphthylamine

Eleven (11) personal air samples were obtained and no alpha or beta naphthylamine was detected (less than 0.001 mg/tube or approximately 0.05 mg/M^3) in any of these samples. Better sensitivity is necessary concerning the analytical and particularly the sampling method (10 times the volume or more, approximately 0.2 M^3 or more) before any definitive statement can be made concerning alpha or beta naphthylamine concentrations and any associated hazards to the worker. However, subsequent analysis of bulk samples of the coal tar pitch showed no detectable amount (less than one tenth of one percent) of alpha or beta napthylamine. Hence, it would appear that alpha or beta naphtylamine does not appear to present a problem in this operation.

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

Seventeen (17) low volume personal air samples were obtained using charcoal tube samples on September 4, 1975, and no organic compounds were detected (less than 1 mg total hydrocarbons per tube and less than 0.05 mg benzene per tube, if present). These samples were obtained to more fully identify the various components of the vapors to which roofers are exposed during operations. In addition, four higher volume general area samples were obtained for additional sensitivity using MSA Model "G" pumps. All four samples gave positive results at the lower levels of detection. The two highest sample results are summarized in Table III. The chromatograms of these samples appeared to be similar. Sample No. L-7 (not in series with a filter) was run by mass spectrometry in an effort to identify as many peaks as possible. Most of the early peaks were identified as aliphatic type hydrocarbons such as decanes (C10), dodecanes (C12) and undecanes (C11) of miscellaneous structures. Benzene was also found to be present but could not be accurately quantitated because of the background interference from other hydrocarbons. Naphthalene and acenaphthene were also identified and the possibility of other compounds such as methyl naphthalenes, phenethrene, or anthracene were indicated. Sample No. CT-1 was in series behind filter sample No. 55 and shows that organic compounds (particularly lower molecular weight hydrocarbons) are indeed passing through the glass fiber-silver membrane filters plus the backup pad (in series). It appears from this data that more of the lower molecular weight organic compounds than the higher molecular weight compounds pass through the filters and backup pad.

d. General Discussion of Environmental Results

From the data presented in Tables I, II and III, it can be seen that a significant amount of PPOM as well as PAH passes through the glass fiber-silver membrane filters and are absorbed on the backup pad. Some materials, especially the lower molecular weight compounds pass through the backup pad. This study demonstrates a need to improve the identification of the analytical and sampling methodology for BaP and BeP, alpha or beta naphthylamine and PAH. Although larger volumes will improve the detection limit, additional sensitivity is needed for analysis of samples. Further, there needs to be improvement not only in the sampling methodology but also in the analytical methodology to enable a more precise and reproducible results for PPOM including PAH, the biologically important components of these fractions and for other organic compounds to which roofers are exposed.

2. Medical Results and Discussions

a. Demographic Data

All the employees examined were males, their ages ranged from 18-60 with a median age of 33. Four men were aged between 18 and 20, 10 between 21 and 30, 10 between 31 and 40, 8 between 41 and 50 and two over 50. Twenty-five

men were Caucasian, 5 Negro and 4 Spanish-American. Fourteen men had hair color arbitrarily classified as black, 15 as brown, 2 blonde and 3 red. Eye color was arbitrarily classified as brown in 22 individuals, hazel in 4, blue in 8. Complexion was classified as dark in 13 individuals, medium in 14 and light in 7. All the Negro and 3 out of 4 of the Spanish American subjects had black hair, brown eyes and dark complexions. Thirty men described their occupation as roofing, excluding 2 management personnel and 2 members of the ground crew. The time spent as a roofer ranged from 6 weeks to 25 years with a median time of 6 years. Six men had been employed as roofers for less than 1 year, 12 for between 1 and 10 years, 6 from between 10-20 years and 6 for more than 20 years. Less experienced men generally tended to be in the classifications of insulation layers, felt machine helpers, hot carriers, and miscellaneous help. It was clear that roofers do not work with the same job description from one place of employment to another. All the more experienced roofers had worked at one or another in all phases of roofing operations so that over a lifetime of roofing they were exposed frequently to all aspects of the craft. As far as this particular project was concerned, 22 men had worked on the project 3 months, 5 for 2 months, 5 for 1 month, 2 had been involved with the project for longer than 3 months in the planning stages rather than the actual operations.

b. Skin Reactions

Skin symptoms attributed to pitch exposure had been noted on the current job by 23 of the 34 examined workers, while 5 workers complained of symptoms attributed to fibrous glass exposure. The distribution of these employees by job classification on the day of the site visit is shown in Table IV. It should be noted that workers were not necessarily always in the same job position. Moreover, workers at any task, especially on windy days, might be exposed to fumes generated by those working in other positions.

The symptoms attributed to pitch exposure ranged from a burning sensation on the skin upon sun exposure occurring on one or a few occasions to fairly severe skin irritation and blistering. The nature of the skin complaints and number of men complaining of each are given in Table V. Nineteen of the 23 men attributed the symptoms and in particular the burning sensation to exposure to sun and pitch, 4 men to pitch alone. Most men described the burning sensation on sun exposure as having a slightly different character to the sensation of sunburn. It was characterized as being a sharper 'burn or tingling sensation', as 'like a match burn, worse than the sun', or as 'like an open flame'. Although one man described tanning as a result of pitch exposure, several other workers specifically commented on the failure to tan after a 'pitch-burn'.

The sites of the body where symptoms were described are listed in Table VI. It is seen that exposed sites were those generally affected. Only two workers described reactions on unexposed sites, one of burning occurring occasionally 'through the shirt' and one of some burning occurring from

under his gloves, a symptom which was greatly accentuated on subsequent sun exposure. Men who developed symptoms on the hands or arms generally described these occurring only if the sleeves were rolled up or gloves were not worn. Men who referred to specific sites of involvement of the face most commonly mentioned the nose (7), forehead (4), and creases such as those around the nose or eyes (4).

In general the burning was described as starting while the worker was exposed to pitch and sunlight and as continuing to get worse as long as these exposures continued. The burning might begin within an hour of exposure and would begin to diminish that evening. In some men erythema and blistering would follow the onset of burning. Peeling would commence from 2 to 5 days later and would occur sooner if the 'burn' had been more severe. Peeling occurred quite often in the absence of any discernible erythema. These 'burns' usually left no appreciable tan, if any occurred, it was generally lost in the peeling stage. Burns tended to occur all summer without a great deal of subsequent protection following the occurrence of symptoms.

Factors which were described as exacerbating the condition are tabulated in Table VII. All men described pitch exposure as a major factor, usually referring to exposure to pitch fumes although three workers described their main problem as caused by direct skin contact with pitch. Sun exposure was cited as the other major factor. The relation to cloudless days or summer may reflect greater sun (ultraviolet) exposure on these days. Several workers described heat as an important factor; 3 workers specifically described either heat (2) or sweating (1) as being the major factors rather than sun exposure. The references either to windy or cloudless days as being important factors appeared to depend on the particular job being performed. Workers near but not specifically working with pitch cited windy days as worse if pitch fumes were blown towards them, whereas those working with pitch described symptoms as worse on calm days when the operations were thereby poorly ventilated. Four workers specifically cited old style pitch as causing more skin symptoms than certain more recently developed pitches styled as 'no burn' or less volatile pitches, although it seemed clear that some symptoms were definitely attributable to the latter also. Two roofers stated that more severe symptoms were associated with exposure to old pitch from "tear-off" operations when an old roof is removed. One roofer cited pitch fumes from pitch used at a higher temperature than normal as having a greater propensity to cause skin symptoms.

Seven employees could not describe any measures which they felt were useful in protecting against symptoms. Measures cited as being of variable usefulness included wearing gloves (by 13 employees), long sleeved shirts (4), hat (1), using various emollient creams (9), protective lipsticks (2), an unidentified prescription protective cream (1), avoiding fumes (1) and a hot shower after work (2). Few workers had tried using sunscreens and none cited any successful prophylaxis from sunscreens.

Only one employee had sought medical treatment for these symptoms which appeared to be generally accepted as part of the roofing trade. None of the workers

was currently taking a potentially photosensitizing drug. The only relevant family history or past history of skin disease was a family history of skin cancer in one individual.

Five workers described symptoms which they attributed to fibrous glass. Three described itching on areas of the skin contacting fibrous glass. Two described the development of pruritic papules on the elbows and knees of one worker and on the wrists of another.

No employees described any symptoms which they related to asphalt exposure apart from occasional thermal burns from accidental contact with hot asphalt.

Table VIII lists the dermatologic diagnosis made after examination of the 34 roofers. Six employees had localized erythema or desquamation (in one instance with associated hyperpigmentation) which was attributed to pitch photosensitivity. In four instances exposure to pitch fumes appeared responsible, in 1 instance a brief skin contact with hot pitch and in 1 instance both contact with pitch fumes or molten pitch were possible. One employee had a papular dermatitis on the hands and knees consistent with fibrous glass dermatitis and two had evidence of small healing localized thermal burns.

A number of skin disorders which are generally considered to be sun-induced were diagnosed. The potential contribution of pitch photosensitivity, if any, to these disorders could not be determined. These included evidence of fairly generalized erythema of exposed areas (acute sunburn) in 5 roofers, or varying degrees of solar elastosis in 15 and of excessive fine telangiectasia of the face and neck in 6 roofers. One roofer had multiple (6) actinic keratosis on the hands and neck. He also had a strong family history of skin cancer. Two roofers had other conditions (contact dermatitis, verruca vulgaris) which did not appear definitely related to their work exposures.

c. Eye Problems

Of the 34 roofers examined, 7 usually wore spectacles, 2 wore spectacles for reading only and one usually wore contact lenses. The majority of roofers used some eye protection at least sometimes during their work. Fourteen usually wore sunglasses or tinted spectacles to protect their eyes during roofing operations, 2 used sunglasses occasionally but did not indicate any specific times at which these were used. Ten roofers indicated that they wore spectacles only for specific roofing operations, 8 when they worked with pitch, 1 with fibrous glass insulation and one only for tear-off operations when old roofs were being removed. Two men did not use tinted spectacles or sunglasses but used goggles for tear-off operations as did several roofers who used sunglasses at other times. Five interviewed roofers never used eye protection. The use of protective eye devices is summarized in Table IX.

Nineteen roofers described eye irritation during this job. The distribution of eye complaints by job classification is shown in Table X. Seventeen described eye symptoms which they attributed to pitch exposure and two workers' symptoms which they attributed to fibrous glass.

Of the seventeen workers who described symptoms associated with pitch exposure, 8 described only slight burning or grittiness, usually on sun exposure; 5 burning and mild conjunctival erythema often with excessive lacrimation. Four described more severe episodes with symptoms including burning conjunctival erythema, lacrimation and swelling of the lids, sometimes with associated conjunctival discharge, lids swollen shut, or inability to close the eyes and interference with vision. One roofer complained that he had been unable to sleep at night on several occasions because of these symptoms. Of the 17 symptomatic workers, 11 described the condition as being either exacerbated by sunlight or only occurring due to a combination of pitch and sunlight, 2 as having exacerbations in summer, 1 on cloudless days and 1 in hot weather. Five of these roofers made the observation that sunglasses helped considerably to prevent the condition, 1 that glasses had no effect. One had a past history of removal of the right eye, there was no other prior history of serious eye disease. Only 1 of the symptomatic workers had sought medical attention for conjunctivitis or associated conditions. Eight symptomatic employees used nonprescription eye drops to alleviate the condition, frequently applying these every night after work, 2 used nightly eye washes and 1 described benefit from washing the eyes carefully in a long shower after work.

The incidence of conjunctivitis and of pterygia on physical examination of the eyes of the 34 examined workers is shown in Table XI. Six roofers were found to have evidence of conjunctivitis of either mild (4) or of moderate (2) degree. Each of these workers complained of conjunctival symptoms due to pitch exposure, although each considered his problem to be no more than mild on the day of examination. Two of these roofers were currently assigned to the felt machine crew, 1 to the gravel crew, 2 to the header and flashing crew and 1 as miscellaneous help. The latter employee had had considerable exposure to pitch fumes the prior day.

Virtually all the roofers who had worked at roofing operations for more than a few months described eye symptoms, which were often severe, associated with other roofing jobs. Three circumstances were described where more severe eye problems were particularly prone to occur:

1. Scratching and tear-off operations where old roofs were removed. Practically all experienced roofers described quite severe eye symptoms associated with these operations especially if ventilation was poor, the operation very dusty or there was much associated sun exposure;

2. The use of old-style pitch (rather than the so-called 'no burn' or less volatile pitch such as that used during the operation under investigation);

3. Exposure to pitch fumes when the pitch was at a temperature higher than the usual operating temperature. None of these conditions could be further studied during this hazard evaluation.

Based on the experiences of all the interviewed roofers, the following description of an instance of severe eye inflammation as suffered by roofers can be given. The onset of a severe episode usually starts during a shift, generally after 3 to 4 hours of the shift have elapsed. Often the first symptoms of burning eyes and lacrimation occur at about or after 12 noon. Sunlight will cause severe burning of the eyes and if the roofer looks at the sun, even briefly, he is subsequently likely to suffer from severe symptoms. The severity of the symptoms will increase rapidly and the roofer is likely to have to leave work early. At this time there will be burning in the eyes, conjunctival erythema, increased tearing and swelling of the eyelids. Vision may be disturbed. Erythema of the outer surface of the lids may occur. Instilling bland eye drops may give a little temporary relief, local anesthetic drops will temporarily abate the burning sensation. The symptoms will be most severe that night and it may be very difficult or impossible to sleep. By morning the eyelids may be matted and a purulent discharge will be evident. The symptoms will then gradually abate although they may last through the next night. The more severe the episode the longer it will last. However, by 72 hours after the onset the symptoms will have completely abated. Mild degrees of this condition are very common especially if old-style pitch is used or during a tear-off or scratching operation. In such instances symptoms may be present almost continuously, especially during sunny periods in summer. In such circumstances, however, there will be some tendency to show improvement at weekends. The pattern of these reactions tends to be the same regardless of the type of pitch (old style, from tear-off operations, etc.) which is considered causal, although the reactions may vary in severity.

Two employees complained of slight, occasional transient irritation from fibrous glass. Both commented that the irritation was not as severe as that observed after pitch exposure. Neither was symptomatic or showed abnormalities on eye examination on the day of examination.

No workers described any eye symptoms which appeared attributable to asphalt.

d. Discussion of Medical Results

Skin reactions of mild to moderate degree associated with pitch exposure were described by 23 out of the 34 roofers on this project. Six roofers had evidence of localized reactions on exposed sites on examination. Five other roofers had more diffuse erythema on exposed areas which may have represented a reaction to sunlight alone, although the reaction could have been compounded by occupational exposure to pitch. These reactions appear consistent with the photosensitivity reactions to pitch which have previously been described (Cavalie, 1954[14]). These depend for their development on exposure to both pitch and ultraviolet radiation, usually

from sunlight. The dependence on sun exposure and the various weather conditions as described was consistent with this etiology. From the histories given it seems that the usual causal exposures were to pitch fumes rather than to molten pitch. It was also apparent that certain other variables may affect the photosensitivity response to pitch. From the description by the roofers who were examined the less volatile pitch at the usual operating temperatures as used on this job appears to be less potent in causing this response than the so-called "old-style" pitch. In addition, although not relevant to this particular job, it appeared that certain operations such as tearing off and scratching old roofs or laying new, roofers using pitch at a higher than normal temperature may be associated with a higher incidence of complaints.

It is theoretically possible that pitch photosensitization may increase the likelihood that a worker will develop either skin cancer (Emmett, 1973[15]) or actinic elastosis (Emmett, 1975a[16]) from sun exposure. Moreover, certain pitch fractions are known to be carcinogenic to the skin of experimental animals in their own right (Emmett, 1975b[17]). No malignant lesions of the skin were noted on this survey. One roofer had multiple pre-malignant actinic keratoses; however, he also had a family history of skin malignancy and there was not strong evidence that the keratoses were caused by occupational rather than other exposures. There was a relatively high incidence of the degenerative skin changes described as actinic elastosis (with skin thickening, furrowing, yellowing, plaques, and cysts) and of fine telangiectasia (excessive dilation of the small vessels of the skin) in the examined roofers; however, without a more definitive epidemiologic study utilizing a control group for comparison one could not determine whether the incidence was abnormally high. This is particularly true as sun exposure alone may cause these changes.

Although most of the scientific attention to the health problems of pitch has been directed to skin changes, it was apparent from the results of this survey that eye problems occurred almost as commonly and tended to cause at least as much morbidity in this group of roofers. From the histories obtained these symptoms appeared to be virtually all related to exposure to pitch. Moreover, the six examined roofers with clinical evidence of conjunctivitis had all been exposed to pitch fumes on the day of examination or the preceeding day. Conjunctivitis was noted on examination of 4 of the 6 roofers exposed to time weighted average concentrations of greater than 0.2 mg/M^3 of PPOM on the day of the evaluation and was noted in two of the 20 roofers with exposures of less than that level. This difference is statistically significant at $P = 0.012$ by Fisher's Exact Test. According to the worker's histories, more severe eye reactions were associated with exposure to so-called old-style pitch rather than the less volatile pitch used on this job with tear-off and scratching operations for the removal of old roofs and with fumes from pitch being worked at higher than usual operating temperatures.

Only occasional extremely mild eye reactions appeared to be associated with exposure to fibrous glass. None were observed during this study. There

was no discernible link between asphalt exposure and eye symptomatology or findings.

The occurrence of four pterygia amongst this group of roofers was of interest. These eye lesions are characterized by the flat superficial vascular tissue fold onto the cornea. This lesion usually increases slowly, although it may remain stationary for long periods of time. Pterygi are often thought to occur due to exposure to warmer climates, out of doors, wind, dust and sunlight or reflected solar radiation. (Donaldson, 1971[18]). It is possible that they are causally related to occupational exposures in roofing operations such as sunlight and pitch; however, a larger study incorporating a suitable control group would be necessary to evaluate this possibility.

F. Conclusions

The following conclusions are based upon the above environmental and medical findings:

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

2. Chronic skin and eye conditions were detected within the group of exposed workers but the relationship to occupational exposures, if any, could not be determined from the results of this study.

3. On both days when the environmental evaluations were undertaken some roofers were exposed to airborne concentrations of PPOM in excess of the ACGIH recommended TLV of 0.2 mg/M^3. On September 4, 1975, when both the medical and environmental evaluations were undertaken, there was a statistically significant correlation between workers exposed to concentrations above this level and the occurrence of conjunctivitis as detected by physical examination.

4. The level of exposure to airborne materials in roofing operations is very variable and depends greatly on environmental factors such as wind, and probably on operational conditions such as temperature and type of pitch.

5. 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, and season of the year. The type of roofing operation such as tear-off or scratching operations when an old roof is removed or of laying a new roof appears to influence the incidence and severity of reported reactions.

6. 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.

7. There was no particular evidence from either the environmental or medical results of this survey to believe that fibrous dust or asphalt fumes made an important contribution to the acute skin and eye problem sustained by the roofers.

8. From the environmental data, it appears that the particulate filters may not remove a significant proportion of the PPOM and other organic volatiles to which roofers are exposed. In view of this, it may appear prudent to evaluate the current recommended respirators (e.g., air-purifying respirator equipped with high efficiency particulate filter) as to their adequacy for this type of exposure. It may be more efficacious to utilize a respirator with high efficiency particulate filter followed by an organic vapor or charcoal filter cartridge.

G. Recommendations

In view of the 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 to roofing pitch or pitch fumes.

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 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 fumes or molten pitch should be washed promptly with soap and water or a waterless cleanser.

4. Skin should be protected from pitch vapors and from sunlight as much as possible. Long sleeve shirts, buttoned cuffs, cuffless pants that are full length and cover the tops of his shoes, work shoes that are ankle high, gloves that have no gauntlets or cuffs and are tight at the wrists should be used at all times.

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 saving is in effect this would be between 11 a.m. and 3 p.m.

6. Every effort should be made to avoid exposure to pitch fumes. These measures should include:
   a. All employees should stay upwind of pitch fumes at all possible time

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

c. Kettles and tanks should be downwind from roofing operations.

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

7. 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 the thermostatically controlled tanks or kettles, and thermometers or other temperature sensitive devices.

8. Glasses or goggles should be worn whenever roofing operations utilizing pitch are in process.

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. 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 provisions of 30 CFR Part 11. The employer shall select and provide the appropriate respirator from the list below and shall assure 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.

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TABL.

ENVIRONMENTAL RESULTS OF BREATHING ZONE (PERSONAL) AND GENERAL AREA SAMPLES OBTAINED DURING NEW ROOFING OPERATIONS ON A NEW FORTY-SIX (46) ACRE WAREHOUSE IN LENEXA, KANSAS, ON SEPTEMBER 4, 1975. (ALL SAMPLE RESULTS EXPRESSED AS MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED - mg/M^3).

JOB DESCRIPTION OR LOCATION	SAMPLE* NUMBER	TIME AM PM	SAMPLE VOLUME LITERS	PARTICULATE POLYCYCLIC ORGANIC MATTER (PPOM)** AS CYCLOHEXANE SOLUBLES mg/M^3	RANGE OF POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)** mg/M^3
Hoisting Engineer (SGT)	47T	7:00-1:12	633	0.22	<0.003
Gravel-Pitch Machine Operator A (CT)	62T	7:00-1:12	633	<0.03	<0.003
	18R	7:00-1:12	Lost	Lost	Lost
Gravel-Pitch Machine Operator B (SGT-CT)	49T	7:00-3:18	847	0.45	<0.002
Gravel-Pitch Machine Operator C (CT)	44T	7:00-12:47	590	0.03	0.003-0.029
	37R	7:00-12:47	590	0.29	0.005-0.036
Felt-Pitch Machine Operator A (CT)	45T	7:00-3:20	850	<0.02	<0.002
	6R	7:00-3:20	850	<0.02	0.002-0.020
Broom Operator A (CT)	48T	7:00-3:20	850	0.12	0.002-0.016
	7R	7:00-3:20	850	<0.02	0.002-0.012
Support Operator A (CT-SGT)	39T	7:00-3:20	850	<0.02	<0.002
Felt-Pitch Machine Operator B (SGT)	1T	7:01-3:16	842	0.21	<0.002
	29R	7:01-3:16	842	0.07	0.002-0.024
Broom Operator B (CT)	56T	7:00-11:00	408	0.17	<0.004
	11R	7:00-11:00	408	0.49	<0.004
Support Operator B (CT-SGT)	65T	7:00-2:12	735	0.46	<0.003
Hot Pitch Machine Carrier-Operator A (SGT)	10T	7:00-3:10	833	0.16	<0.002
Hot Pitch Machine Carrier-Operator B (CT)	50T	7:00-3:20	850	<0.02	0.002-0.02
Hot Asphalt Machine Operator A (SGT)	12T	7:00-3:11	835	<0.02	<0.002
	35R	7:00-3:11	835	<0.02	<0.002

TABLE . ont.)

JOB DESCRIPTION OR LOCATION	SAMPLE* NUMBER	TIME AM PM	SAMPLE VOLUME LITERS	PARTICULATE POLYCYCLIC ORGANIC MATTER (PPOM)** AS CYCLOHEXANE SOLUBLES mg/M^3	RANGE OF POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)** mg/M^3
Insulation Layer A (SGT)	54T	7:00-2:59	814	0.10	<0.002
	23R	7:00-2:59	814	0.05	<0.002
Insulation Layer A (CT-CT)	40T	7:05-3:00	808	<0.02	<0.002
Hot Asphalt Machine Carrier-Operator B (CT)	2T	7:00-3:02	820	0.18	<0.002
	15R	7:00-3:02	820	0.06	0.006-0.024
Insulation Layer B (CT-CT)	27T	7:00-2:51	801	0.05	<0.002
Insulation Layer B (CT)	58T	7:00-3:08	830	<0.02	<0.002
Hot Asphalt Machine Carrier-Operator A (SGT)	16T	7:00-3:10	833	0.19	<0.002
Hot Asphalt Machine Carrier-Operator B (CT-SGT)	38T	7:00-3:14	840	<0.02	0.002-0.012
Hedder & Flashing Operator A	64T	7:39-3:20	784	<0.03	<0.002
	24R	7:39-3:20	784	<0.03	0.004-0.017
Hedder & Flashing Operator A (CT)	28T	7:35-3:15	782	0.03	0.003-0.022
Hedder & Flashing Operator B (CT)	53T	7:37-3:15	779	0.04	<0.002
Hedder & Flashing Operator B (SGT)	41T	7:36-3:22	792	0.08	0.003-0.018
Hedder & Flashing Operator B	34T	7:34-3:26	802	0.09	0.002-0.037
	21R	7:34-3:26	802	<0.02	0.005-0.050
Ground Hot Pitch and Asphalt Operator	20T	6:29-2:30	818	0.07	0.004-0.016
	19R	6:29-2:30	818	0.12	0.002-0.017
Area Gravel-Pitch Machine "C" (CT)	43T	7:30-12:51	546 est.	0.49 (0.20)	0.011-0.082 (0.007-0.051)
Area Felt-Pitch Machine A (CT)	42T	8:30-2:14	585 est.	2.38 (0.72)	0.232-2.027 (0.063-0.54)
	32R	8:30-2:14	585 est.	0.72 (0.32)	0.070-0.545 (0.044-0.342)
Area Felt-Pitch Machine B (CT)	57T	8:30-1:55	553 est.	1.16 (0.72)	0.009-0.049 (0.005-0.024)
	23R	8:30-1:55	553 est.	0.07 (<0.04)	<0.003

TABLE I (cont.)

*T=total dust or particulate R=respirable dust or particulate

**The American Conference of Governmental Industrial Hygienists (ACGIH) recommended eight-hour time-weighted average Threshold Limit Value (TLV) for PPOM as benzene solubles is 0.2 mg/M^3. The difference between benzene solubles and cyclohexane solubles is insignificant and for most practical purposes are considered the same. There are no ACGIH recommended TLV or Federal Occupational Health Standards for PAH.

NOTES: Separate analytical measurements were made on the silver membrane-glass fiber filters and the backup pad for all area samples and several of the personal samples. The numbers shown without parenthesis are for the total concentration and the numbers within the parenthesis are for the concentration found on the backup pad only; e.g., 0.50 (0.17) shows a total concentration of 0.50 mg/M^3 which includes 0.17 mg/M^3 found on the backup pad. Also, CT or SGT in parenthesis under "Job Description" shows samples were also obtained using a charcoal tube or silica gel tube, respectively. (Refer to text of report for results of CT and SGT samples).

TAB

ENVIRONMENTAL RESULTS OF BREATHING ZONE (PERSONAL) AND GENERAL AREA SAMPLES OBTAINED DURING NEW ROOFING OPERATIONS ON A NEW FORTY-SIX (46) ACRE WAREHOUSE IN LENEXA, KANSAS, ON SEPTEMBER 18, 1975. (ALL SAMPLE RESULTS EXPRESSED AS MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED - mg/M^3).

JOB DESCRIPTION OR LOCATION	SAMPLE* NUMBER	TIME AM PM	SAMPLE VOLUME LITERS	PARTICULATE POLYCYCLIC ORGANIC MATTER (PPOM)** AS CYCLOHEXANE SOLUBLES mg/M^3	RANGE OF POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)** mg/M^3
Gravel Pitch Machine Operator A	13R	8:12-3:15	719	0.24 (<0.03)	<0.008-0.024 (0.006-0.024)
Gravel Pitch Machine Operator B	36T	8:19-1:19	510	<0.04	<0.007-0.014 (0.004-0.014)
Felt-Pitch Machine Operator A	46T	8:25-3:25	714	0.04 (0.01)	0.015-0.134 (0.007-0.060)
Broom Operator A	17T	8:36-3:10	670	0.40 (0.24)	0.012-0.051 (0.006-0.025)
Felt-Pitch Machine Operator B	59T	8:25-3:10	689	<0.03	0.012-0.110 (0.006-0.052)
Broom Operator B	5T	8:40-3:20	680	0.53 (0.43)	0.015-0.118 (0.010-0.074)
Hot Asphalt Machine Carrier-Operator	63T	8:30-3:05	672	0.10 (0.07)	<0.007-0.019 (<0.002)
Area Gravel A	52T	8:03-2:30	658	0.50 (0.17)	0.050-0.350 (0.029-0.198)
	14R	8:03-2:30	658	0.26 (0.08)	0.021-0.111 (0.018-0.076)
Area Gravel A (CT)	55T	8:03-2:30	542	<0.04	0.030-0.218 (0.020-0.153)
Area Gravel B	8T	8:10-2:35	658	0.09 (<0.03)	0.009-0.096 (0.003-0.070)
	3R	8:10-2:35	658	0.33 (<0.03)	0.010-0.030 (0.008-0.030)

*T=total dust or particulate R=respirable dust or particulate

**The American Conference of Governmental Industrial Hygienists (ACGIH) recommended eight-hour time-weighted average Threshold Limit Value (TLV) for PPOM as benzene solubles is 0.2 mg/M^3. The difference between benzene solubles and cyclohexane solubles is insignificant and for most practical purposes are considered the same. There are no ACGIH recommended TLV or Federal Occupational Health Standards for PAH.

NOTES: Separate analytical measurements were made on the silver membrane-glass fiber filters and the backup pad for all area samples and several of the personal samples. The numbers shown without parenthesis are for the total concentration and the numbers within the parenthesis are for the concentration found on the backup pad only; e.g., 0.50 (0.17) shows a total concentration of 0.50 mg/M^3 which includes 0.17 mg/M^3 found on the backup pad. Also, CT or SGT in parenthesis under "Job Description" shows samples were also obtained using a charcoal tube or silica gel tube, respectively. (Refer to text of report for results of CT and SGT samples).

TABLE III

RESULTS FROM TWO CHARCOAL TUBE SAMPLES OBTAINED DURING ROOFING OPERATIONS (SAMPLE RESULTS ARE EXPRESSED AS MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED - mg/M^3) - LENEXA, KANSAS

Sample Number L-7 was on Felt-Pitch Machine A on September 4, 1975, from 8:30 a.m. to 2:14 p.m. with an estimated volume of 140 liters.

Total Organics	14.50 mg/M^3 - 29.00 mg/M^3
Total low molecular weight compounds*	7.25-14.50 mg/M^3
Highest single component	~1.45 mg/M^3
Total high molecular weight compounds*	7.25-14.50 mg/M^3
Naphthalene	~1.45 mg/M^3
Acenaphthene (highest single high component)	~2.90 mg/M^3

Sample No. CT-1 was placed in series behind filter sample No. 55T on Gravel Pitch Machine A on September 18, 1975, from 8:03 a.m. to 2:30 p.m. with an estimated volume of 542 liters.

Total Organics	4.98 mg/M^3 - 7.01 mg/M^3
Total low molecular weight compounds*	4.61-6.46 mg/M^3
Highest single low component	~0.92 mg/M^3
Total high molecular weight compounds*	0.37-0.55 mg/M^3
Naphthalene	~0.18 mg/M^3
Acenaphthene	~0.18 mg/M^3

* For this table "low molecular weight compounds" were defined as those compounds eluting before naphthalene and "high molecular weight compounds" refer to naphthalene and above.

TABLE IV

Distribution of Symptoms Referable to the Skin
By Job Classification
(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Job Category	Number of Employees	Symptoms Attributed to Pitch	Symptoms Attributed to Fibrous Glass
Project Management	4	0	1
Felt Machine Crew	5	4	0
Gravel Crew	4	3	0
Insulation Crew	9	5	4
Hot Carriers	2	2	0
Header & Flashing	5	5	0
Miscellaneous Help	2	2	0
Ground Crew	3	2	0
TOTAL	34	23	5

Table V

Nature of Complaints Related to the Skin
Attributed to Pitch Exposure in 23 Workers
(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Burning	21
Tingling sensation	2
Itch	1
Irritation of Skin	1
Tingling if hands in cold water	1
Erythema	8
Peeling	11
Blistering	3
Tanning	1
Cracked, burning lips	2

Table VI

Sites of Body Affected in 23 Workers Complaining of Skin Symptoms Attributed to Pitch Exposure

(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Face	19
Neck	11
Lips	8
Arms	4
Wrists	1
Hands	5
Trunk	1

Table VII

Exacerbating Factors Described by 23 Roofers
with Symptoms Related to the Skin

(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Pitch exposure	23
Sun exposure	19
Cloudless day	9
Summer	4
Hot day	4
Old style pitch	4
Calm day	3
Tear-off operation	2
Windy day	2
Pitch at high temperature	1
Profuse sweating	1

Table VIII

Clinical Dermatologic Diagnoses in
34 Roofing Employees

(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Diagnosis	No. of Affected Workers
Probable Work Related Conditions	
Erythema	
Generalized erythema of exposed areas	5
Erythema anterior aspect of neck	2
Erythema face and neck	1
Erythema upper lip	1
Erythema lateral aspect left hand	1
Desquamation dorsal aspect of hands	2
Papular dermatitis (fiber glass)	1
Thermal burns	
Recent healing	2
Scars (forearms)	3
Chronic sun-induced conditions	
Actinic elastosis	15
Mild degree	6
Moderate degree	6
Marked degree	3
Fine telangiectasia neck or face	6
Multiple actinic keratoses	1
Other conditions	
Contact dermatitis	1
Verruca vulgaris	1

Table IX

Use of Eye protection During Roofing Operations by 34 Roofers

(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Eye Protection	No. of Workers Using
Sunglasses or Tinted spectacles*	
Usually used	14
Occasionally used	2
Used for specific operations	10
Pitch fume exposure	8
Fibrous glass exposure	1
Tear off operations only	1
Goggles for Tear-Off Operations Only	2
Contact Lenses	1
No Eye Protection Used	5

* Several workers who usually or sometimes used sunglasses or tinted spectacles also used goggles for tear-off operations.

Table X

Distribution of Eye Complaints
by Job Classification
(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Job Category	Number of Employees	Symptoms Attributed to Pitch	Symptoms Attributed to Fibrous Glass
Project Management	4	0	0
Felt Machine Crew	5	3	0
Gravel Crew	4	3	0
Insulation Crew	9	2	1
Hot carriers	2	1	0
Header & Flashing Crew	5	5	0
Miscellaneous Help	2	2	1
Ground Crew	3	1	0
TOTAL	34	17	2

Table XI

Incidence of Conjunctivitis and
Pterygia on Examination of 34 Roofers
(Roofing Operations - Lenexa, Kansas - September 4, 1975)

Bilateral conjunctivitis, moderate degree*	1
Unilateral conjunctivitis, moderate degree	1
Bilateral conjunctivitis, mild degree**	4
Pterygium	4

*Conjunctivitis, moderate degree:- Moderate edema of the eyelids, blepharospasm, increased mucous secretion, moderate to severe conjunctival hyperemia.

**Conjunctivitis, mild degree: -Mild to moderate conjunctival hyperaemia, with or without slight swelling of the lids and excessive lacrimation.