US 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 #76-56-458
HERBERT MALARKY ROOFING CO.
PORTLAND, OREGON

January, 1978

I. TOXICITY DETERMINATION

It has been determined that:

1. The slate man, press man, granule man and coater man were exposed to excessive concentrations of total dust. The granule man was also exposed to excessive concentrations of free silica. These determinations are based on breathing zone concentrations that were in excess of the evaluation criteria used for this study. In addition, dryness of the nose and throat was experienced by these workers.

2. The saturator man's exposure to asphalt fume was not considered to be toxic based on the 8-hour 5 mg/cu m time weighted average criterion in existence at the time the environmental sampling was conducted. The recently published NIOSH criterion of 5 mg/cu m for any 15 minute period could be exceeded, however, when he has to spend at least 15 minutes inside the saturator during times of rethreading or other maintenance work. This is based on a concentration of 53 mg/cu m of asphalt fume measured in the saturator.

3. Excessive concentrations of dust and asphalt fume were present in the area on the decks above the coater. This determination is based on the fact that area samples showed that the total dust and asphalt fume concentrations were 5 to 11 times the evaluation criteria. This area is not a normal work station; however, anyone working in this area to perform maintenance or other types of work would be subjected to excessive concentrations of total dust and asphalt fume.

4. Employees' exposures to benzo(a)pyrene, other polynuclear aromatics (PNAs), alpha and beta naphthylamines, aliphatic hydrocarbons and aromatic hydrocarbons were not toxic at the concentrations found. This determination is based on the low levels measured or the absence of these compounds in the breathing zone samples taken during this study.

5. Fibrous glass and formaldehyde exposures could not be measured since they were not processed during this study.

6. There were signs of slight eye, nose, throat and skin irritation and dryness of the nose and throat from exposures to dusts and fumes among the employees interviewed. More serious symptoms were not apparent to the investigators and the study did not include further medical followup.

II. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

(1) Herbert Malarky Roofing Co., Portland, Oregon
(2) United Paperworkers Local #1689, Portland, Oregon
(3) United Paperworkers International Union, Flushing, New York
(4) Accident Prevention Division, State of Oregon
(5) Occupational Safety and Health Administration, Seattle, Washington
(6) NIOSH Region 10, Seattle, Washington

For the purpose of informing the affected employees, the employer will prominently post the Determination Report near their work area for a period of thirty (30) calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 USC 669(a)(6), authorizes the Secretary of Health, Education and Welfare, following receipt of a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from the United Paperworkers International Union, Flushing, N.Y. to determine if materials present in the production of asphalt shingles and rolled roofing materials are toxic as used or found. The materials involved are felt, asphalt (petroleum), colored granules, limestone, talc and mica.

IV. HEALTH HAZARD EVALUATION

A. Description of Process

Herbert Malarky Roofing Co. produces asphalt shingles and rolled roofing products. The request involves the production of these products. This plant also produces their own rolled felt and rolled fibrous glass.

The rolled felt is fed in a continuous ribbon through accumulation loops and into the saturator. In the saturator, hot asphalt (petroleum) at approximatley 400 degrees Fahrenheit is sprayed and flowed onto the felt. As the felt exits the saturator, it is completely saturated with the asphalt. The saturating process is enclosed in a cinder block enclosure that has local exhaust ventilation and the entire enclosure is kept under negative pressure. The saturated felt then enters an enclosure where the material is passed over a series of loops for cooling purposes. This enclosure utilizes local exhaust ventilation with the exhaust air being used as the make-up air for the saturator. When the doors to this cooling chamber are left open, the fume escapes into the general atmosphere. After the saturated felt leaves the cooling loops it passes to the coater. At this point, hot asphalt that has been thickened with limestone is flowed on the top side of the felt. It is spread with rollers and passes on to the press area where the colored granules are dropped on the surface and pressed into the asphalt. There is no local exhaust ventilation over the coater or press area, and much fume and dust can be seen in this area. After the granules have been pressed into the asphalt, a mixture of talc and mica (sand has since been used in place of the mica) is applied to the back side of the material to prevent sticking. Again, there are no controls on this process to keep the dust from entering the general atmosphere. From here, the material passes through a water spray for cooling and another series of cooling and accumulation loops. From there, it passes to the cutter where the individual shingles are cut from the continuous ribbon. The shingles are automatically stacked, wrapped and then sent on to the warehouse where they are placed on pallets and put into storage. In addition to the operations described, there are two persons who are involved in handling the slate granules.

There are 13 to 15 employees working in this area per shift for the first and second shifts. The third shift has a reduced crew in that they are running the rolled roofing products. The exposure that these men have to the various chemicals is very diversified. Each operation has a man assigned to it, and his exposure will be mainly to the materials that are added at that point. In addition, the felt ribbon may sustain a break which requires rethreading of the felt through the saturator and removal of the broken felt. In order to accomplish this, the doors of the saturator are opened and one or more employees enter the saturator to do the rethreading. This results in an exposure to the concentrated asphalt fume inside the saturator.

B. Study Progress and Design

1. General

The initial survey was conducted on June 3, 1976. The environmental study was conducted on March 1 and 2 and September 22, 1977. The delay between the initial and environmental study was caused by several separate problems. One involved the operation itself. Shortly after the initial survey, the plant began a revision of the line. It was completed in early fall; however, due to operational difficulties, was not up to production until next spring. Due to analytical problems that occurred on the asphalt fume samples, additional sampling was conducted in September, 1977 for asphalt fume after a two month strike was settled. It was the desire of the union to have the fibrous glass operation studied also. Several problems occurred to prevent this from being accomplished. One was that the rolled fibrous glass operation had been shut down for some time due to mechanical and personnel problems; therefore, they were not running any fibrous glass through the production line. Since there are several evaluation requests involving other plants that do use fibrous glass, it is anticipated that the results found in these would also be applicable to this operation. The recommendations would be identical or very similar.

Employees working in the subject areas may be exposed to several chemicals at the same time. There was no personal protective equipment worn, such as respirators, during this study.

2. Environmental Sampling

The sampling was designed to include all job descriptions. The samples collected were either breathing zone or general area samples. Breathing zone (BZ) samples are collected while the employee wears the sampling equipment and the air is sampled in the close proximity of the mouth. General area (GA) samples are collected in the general area where the employee is working. The following is a list of the number and types of samples collected:

--Asphalt Fume	11
--Cyclohexane solubles	11
--Benzo(a)pyrene (BAP)	28
--Polynuclear aromatics (PNA) other than BAP	11
--Aliphatic and aromatic hydrocarbons	12
--Respirable dust	3
--Total dust	18
--Free silica	6

3. Medical

A short questionnaire was administered to each of the affected employees on the day shift before the shift started and after the shift ended on each of the days. The questionnaire involved the employee's perception of a feeling of dry, sore or irritated throat, dry or irritated nose, eye irritation, and whether or not the skin was itching at the present time and under what conditions, whether working with fibrous glass or felt, the skin was subject to itching. The investigators observed the eyes of the employees and indicated the degree of lacrimation in the eyes using a scale of 0 to 3.

C. Evaluation Methods - Environmental

The employees' potential exposures to the substances present were determined by the collection of samples in the occupations and areas of concern.

1. Asphalt (Petroleum) Fume - The asphalt fume was collected on tared 37 mm filters consisting of a combination of fibrous glass filter and a silver membrane filter using a portable pump operated at a flow rate of 1.0 or 1.7 liters per minute. The asphalt fume collected on the filters was subsequently analyzed for cyclohexane solubles. The cyclohexane soluble material was in turn analyzed for benzo(a)pyrene and other polynuclear aromatic compounds, using a liquid chromatograph equipped with a UV detector.

2. Aliphatic and Aromatic Hydrocarbons (Asphalt Volatiles) - The sampling method consisted of collection of the volatiles on charcoal tubes which were preceded by the fibrous glass-silver membrane filters. Portable sampling pumps operated at a flow rate of 1.0 liters per minute were used. The aromatic and aliphatic hydrocarbons present in the charcoal samples were determined using gas chromatographic techniques.

3. Dust and Particulates - The sampling method consisted of collection of the dust on tared 37 mm filters, using portable pumps operated at a flow rate of 1.7 liters per minute. Depending on further analysis of the material on the filter, the filters used were either vinyl metricel, polyvinyl chloride (FWS-B) filters, or a combination of fibrous glass filters backed up by silver membrane filters. The filters were all re-weighed upon receipt in the laboratory.

4. Silica (Crystalline) - The sampling method consisted of the collection of the material on tared polyvinyl chloride (FWS-B) filters at a flow rate of 1.7 liters per minute, with subsequent analysis by X-ray diffraction. The silica samples consisted of both total dust samples and respirable dust samples.

D. Evaluation Criteria

1. Environmental Criteria - The evaluation criteria applicable to this evaluation is as follows:

The Occupational Health Standards as promulgated by the U.S. Department of Labor, Code of Federal Regulations, revised January 1976, Part 1910, Title 29, Chapter XVII, Subpart Z, Table Z-1, Z-2, and Z-3; American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) for Chemical Substances and Physical Agents in the Workroom Environment for 1977 (1) and NIOSH Criteria Documents for Recommended Occupational Exposure to Alkanes (2), Occupational Exposure to Asphalt Fumes (3), and Occupational Exposure to Crystalline Silica (4).

SUBSTANCE	U.S. DEPT OF LABOR STANDARDS	ACGIH TLVs TWA *	NIOSH RECOMMENDED LEVELS
Alkanes (C5-C8)	-	-	350 mg/cu m
Asphalt (Petroleum) Fume	-	5 mg/cu m**	5 mg/cu m of total particulates for any 15 min. period
Dust (Nuisance) includes mica, non-asbestiform talc, limestone, felt dust, etc.			
Total Dust	15 mg/cu m	10 mg/cu m	-
Respirable Fraction	5 mg/cu m	5 mg/cu m	-
Silica (Crystalline)			
"Total Dust"-respirable & nonrespirable	$\frac{30 \text{ mg/cu m}}{\% SiO_2 + 2}$	$\frac{30 \text{ mg/cu m}}{\% SiO_2 + 3}$	-
Respirable Fraction	$\frac{10 \text{ mg/cu m}}{\% SiO_2 + 2}$	$\frac{10 \text{ mg/cu m}}{\% SiO_2 + 2}$	0.050 mg/cu m of SiO_2 in respirable fraction

* TWA - Time Weighted Average

** mg/cu m - milligrams of substance per cubic meter of air

NOTE: There are no recommended levels for:
1) Benzo(a)pyrene and other polynuclear aromatic hydrocarbons
2) Aliphatic hydrocarbons C-9 - C-16.

2. Toxic Substances Medical Data

The adverse effects from exposure to the substances measured in detectable concentrations are listed below:

Asphalt (Petroleum) Fume (5, 6) - Petroleum asphalt fume contains a large mixture of organic chemicals. It contains condensed particles composed of long chain, complex, high boiling hydrocarbons. It also contains hydrocarbons that are vapors at room temperature. These vapors include the aliphatic hydrocarbons C-5 to C-16 and the aromatic compounds. Benzene may or may not be present in very small quantities, depending on the source and batch of asphalt purchased. Polynuclear aromatic (PNA) compounds may also be present. The PNAs may consist of anthracene, chrysene, phenanthrene, pyrene, and benzo(a)pyrene (BAP), which is a known carcinogen. In general, the components of petroleum asphalt fume may produce eye, nose and throat irritation and may produce a narcotic response in the exposed individuals.

Nuisance Dusts (5) - Nuisance dusts have little adverse effects on the lungs and do not produce significant disease or toxicity when exposures are kept under reasonable control. These dusts are biologically inert in that when inhaled the architecture of the alveoli remains intact; little or no scar tissue is formed; and any reaction provoked is potentially reversible. Excessive concentration in workroom air may reduce visibility, cause unpleasant accumulations in the eyes, ears, nose and secondarily cause injury to the skin due to vigorous cleansing procedures necessary for their removal.

Silica (4) - Finely divided silica in the free state can cause silicosis, a fibrotic lung disease. This form of pneumoconiosis usually occurs only after a number of years of exposure; although it can occur in a short time with severe exposure. The acute form may be recognized after 8 to 18 months from the first exposure. Patients may note severe shortness of breath and rapid breathing and chest X-rays may show fibrosis. However, an uncomplicated case may progress to an advanced stage showing little functional impairment. Chronic silicosis is the type often observed in industry and usually occurs after years of exposure to silica dust. Silicosis often progresses in spite of termination of exposure and becomes incapacitating to the affected workers. Prevention is extremely important since treatment is not effective.

E. Evaluation Results in Discussion

In all cases the most stringent evaluation criteria listed in Section D, paragraph 1, is the one considered for comparison of results.

1. Environmental results:

Asphalt (Petroleum) Fume - Eleven samples (8 breathing zone and 3 general area) were collected for asphalt fume. The results are shown in Table 3.

The criterion for asphalt fume is based on the measurement of the total particulates. In this evaluation, the employees who have an exposure to asphalt fume are exposed to a variety of other dusts also. Because of this, the total particulate method was not considered an accurate measurement of the asphalt fume. A bulk air sample, collected in the saturator, that contained only asphalt fume was dissolved in cyclohexane. The cyclohexane soluble portion was approximately 30 to 33%. Applying this percentage to the samples, an approximate asphalt fume concentration was calculated. The 8 breathing zone samples had a range of 0.6 to 3.2 mg/cu m which is less than the proposed NIOSH criterion of 5 mg/cu m for any 15 minute period. The sample collected in the saturator indicated that the asphalt fume concentration may be at least 53 mg/cu m. Since the concentration of fume in the saturator is high, all employees who enter the saturator to perform work such as rethreading should wear a respirator for use with asphalt fume.

Two general area samples were collected on the first and third decks above the coater. The asphalt fume concentrations were 19.5 and 13.4 mg/cu m and the total dust concentrations were 112 and 55 mg/cu m. These locations are not normal work stations; however, whenever employees have to work on the decks above the coater for more than 15 minutes they should wear respirators for use with asphalt fume and nuisance dusts. The local exhaust system that is to be installed over the coater should prevent the fume from entering the general atmosphere above the coater.

Aliphatic and aromatic hydrocarbons - Twelve air samples were collected for aliphatic and aromatic hydrocarbons. The results are shown in Tables 4 and 5. No aromatic hydrocarbons were detected. The total identified (C-5 and C-16) and unidentified aliphatic hydrocarbons ranged from 0.48 to 15.96 mg/cu m. The evaluation criterion used for the aliphatic hydrocarbons is that of the alkanes (C-5 to C-8). This criterion is 350 mg/cu m. All the samples were less than 5% of this level. Based on the low concentrations the aliphatic and aromatic hydrocarbons are not considered toxic as found.

Benzo(a)pyrene (BAP) and other polynuclear aromatics (PNAs) - Seventeen samples were analyzed for BAP and the results are shown in Table 2. These BAP results were less than 0.04 ug/sample. Eleven additional samples (8 breathing zone and 3 general area) were collected and analyzed for benzo(a)pyrene, benz(a)anthrecene, chrysene, fluoranthene and pyrene using a new analytical method with a lower detection limit. The results are shown in Table 9. Three of the eight breathing zone samples had detectable concentrations of at least one but not more than 2 of the substances looked for. One had 0.211 ug/cu m of pyrene, one had 0.056 ug/cu m of chrysene and 0.047 ug/cu m of fluoranthene, and the third had 0.046 ug/cu m of fluoranthene. There are no recommended standards for these substances at the present time.

Three general area samples were collected at locations where the asphalt fume was known to be present. None of these locations were normal work stations, however, during the course of the day an employee may be required to perform a job in those areas. These general area samples show that the asphalt fume does contain all of the polynuclear aromatics (PNAs) listed in the previous paragraph. Because the PNAs are present in the asphalt fume the employees should wear NIOSH approved respiratory protection for use against asphalt fume when working in the saturator and when working on the decks above the coater.

Cyclohexane solubles - The cyclohexane soluble portions of the samples collected for asphalt fume were determined to calculate the approximate asphalt fume concentration. The results are shown in Table 3. The concentrations ranged from 0.21 to 6.45 mg/cu m. These samples were further analyzed for benzo(a)pyrene and other polynuclear aromatics.

Silica (crystalline) - Six samples (4 total dust and 2 respirable dust) were collected for crystalline silica. The results are shown in Table 6. Both of the respirable dust samples contained less than detectable amounts of free silica. One of the four total dust samples collected for free silica exceeded the evaluation criteria. This was on the granule man whose exposure to the silica-bearing dust was 28.82 mg/cu m or 8 times the evaluation criterion. The granule man needs to wear respiratory protection certified for use against silica.

Total and respirable dust - Twenty-one samples (18 for total dust and 3 for respirable dust) were collected. The results are shown in Table 1. None of the respirable dust samples exceeded the evaluation criterion of 5 mg/cu m. Six of the 18 total dust samples exceeded the evaluation criterion of 10 mg/cu m. Four of these were breathing zone samples and 2 were general area samples. The breathing zone concentrations were: coater man - 11.86 and 15.61, press man - 21.97 and the granule man - 28.82 mg/cu m. These individuals must wear respiratory protection certified for use against dusts, and since the granule man is also exposed to excessive concentrations of free silica (see previous paragraph) his respirator must be certified for use against silica.

Two area samples were collected for total dust on the decks above the coater. The dust level on the first deck was 55 mg/cu m and on the third deck it was 112 mg/cu m. These areas are not normal work areas. These results are 5 to 11 times the evaluation criteria. The local exhaust system that is to be installed over the coater should reduce the asphalt fume contribution included in these dust levels. All sources of dust emission in this area should be identified and controlled at the source.

A bulk air sample collected on silica gel for analysis of alpha and beta naphthylamines revealed that these substances, if they were present, were less the detection limit of 50 ug/sample.

2. Medical Results:

Thirteen workers were interviewed on March 1, 12 on March 2 and 10 on September 22. These were, in most instances, the same persons each day. They were asked for their own perception of pre and post shift eye irritation, dry or irritated throat and when they tended to have skin irritation. Their eyes were observed for redness and lacrimation by the NIOSH investigators who were not physicians. The results are listed in Table 8.

Eye, nose or throat irritation was experienced by one worker on March 1, one on March 2 and one on September 22. One out of 13 workers had slight eye redness on March 1, six out of twelve on March 2 and none on September 22. Five workers had slight post shift eye lacrimation on March 1, two on March 2 and none on September 22. These responses could have been caused by the excessive dust levels and asphalt fume present.

Dryness of the throat was experienced by 5 workers on March 1; six on March 2 and three on September 22. These responses probably resulted from the excessive dust concentrations present on these days.

Eleven out of 11 workers stated that their skin itched at the end of the shift on days that fibrous glass was run; and six out of eleven said their skin itched when felt - impregnated with fibrous glass - was run. Fibrous glass will produce skin irritation on most exposed workers. On March 1 and 2, felt - impregnated with fibrous glass - was run. Three workers stated that their skin itched on March 1 and one had skin irritation on March 2. This response was probably caused by the fibrous glass.

F. Conclusions:

It has been determined that:

1. The slate man, press man, granule man and coater man were exposed to excessive concentrations of total dust. The granule man was also exposed to excessive concentrations of free silica. These determinations are based on breathing zone concentrations that were in excess of the evaluation criteria used for this study. In addition, dryness of the nose and throat was experienced by these workers.

2. The saturator man's exposure to asphalt fume was not considered to be toxic based on the 8-hour 5 mg/cu m time weighted average criterion in existence at the time the environmental sampling was conducted. The recently published NIOSH criterion of 5 mg/cu m for any 15 minute period could be exceeded, however, when he has to spend at least 15 minutes inside the saturator during times of rethreading or other maintenance work. This is based on a concentration of 53 mg/cu m of asphalt fume measured in the saturator.

3. Excessive concentrations of dust and asphalt fume were present in the area on the decks above the coater. This determination is based on the fact that area samples showed that the total dust and asphalt fume concentrations were 5 to 11 times the evaluation criteria. This area is not a normal work station; however, anyone working in this area to perform maintenance or other types of work would be subjected to excessive concentrations of total dust and asphalt fume.

4. Employees' exposures to benzo(a)pyrene, other polynuclear aromatics (PNAs), alpha and beta naphthylamines, aliphatic hydrocarbons and aromatic hydrocarbons were not toxic at the concentrations found. This determination is based on the low levels measured or the absence of these compounds in the breathing zone samples taken during this study.

5. Fibrous glass and formaldehyde exposures could not be measured since they were not processed during this study.

6. There were signs of slight eye, nose, throat and skin irritation and dryness of the nose and throat from exposures to dusts and fumes among the employees interviewed. More serious symptoms were not apparent to the investigators and the study did not include further medical followup.

G. Recommendations:

On the basis of this study the following recommendations are made:

1. Asphalt fumes were escaping through the open doors of the cooling loop enclosure. These doors should be kept closed so all the make-up air will be brought into the enclosure through the designed openings.

2. Local exhaust ventilation should be installed over the coater and press equipment. This is already being planned. The use of this system should prevent the asphalt fume from being emitted to the general work area.

3. All leaks and transfer points in the slate, talc and sand handling system should be identified and the dust emissions reduced through the use of improved maintenance, enclosures and/or local exhaust ventilation.

4. All the hoppers and bins, into which the sand, talc, etc. are dumped should be provided with local exhaust ventilation.

5. Compressed air should not be used to blow dust from equipment. Vacuuming is preferred. If the materials cannot be removed except by the use of blow down, then a NIOSH certified respirator for use with those materials should be worn by the individuals conducting the job.

6. Whenever a worker enters a saturator, he should be required to wear either a NIOSH certified supplied-air respirator or a NIOSH certified respirator consisting of a dust, fume and mist pre-filter in combination with an organic vapor cartridge. Eye protection is also suggested.

7. Whenever a worker performs work on the decks above the coater, he should wear a NIOSH certified respirator consisting of a dust, fume and mist pre-filter in combination with an organic vapor cartridge.

8. Based on other roofing firms using fibrous glass, it is anticipated that the airborne concentrations of fibrous glass would be less than the evaluation criterion. Employees would still be subjected to the fibrous glass particles which will produce an itching and irritation of the skin. Whenever fibrous glass is run, disposable coveralls are suggested for use by the workers. The sleeves, legs and neck openings should be taped tightly against the skin. It is also desirable to change and wash the clothing worn under the coveralls at the end of each shift. Showering after the shift is also recommended.

9. Formaldehyde levels should be measured in the fibrous glass matte production building, in the rolled fibrous glass feed location of the roofing line, during the splicing operation, and at the coater area. The local exhaust system to be provided over the coater should control the formaldehyde as well as the asphalt fume.

10. Coo sand has been substituted for mica since the environmental sampling was completed. A bulk sample of this sand indicates that it contains 60% of free silica. Based on this analysis, the employees who work in the press area and who dump the sand should be evaluated for their exposure to free silica.

11. Until such time that the excessive exposures can be reduced by the use of engineering controls. the individuals who are exposed to those substances should wear NIOSH certified respirators for protection against those substances. Whenever respirators are used, a respirator program that provides for proper selection, fitting, cleaning, maintenance, etc., in compliance with the State of Oregon respirator usage standards, must be followed.

12. Employees who may be exposed to fibrous glass, asphalt fume, free silica and high concentrations of dusts should be provided the following medical surveillance:

    a. Comprehensive medical and work histories with special emphasis directed towards evidence of acute or chronic skin conditions and pulmonary disease and prior exposures in dusty occupations such as those involving exposure to silica, coal dust, and asbestos.

b. Physical examinations giving particular attention to the skin and respiratory system. Examinations should include simple tests for dermographism, and pulmonary function testing when considered to be appropriate by the responsible physician. Eye examinations should also be considered when appropriate.

c. During examinations, applicants or employees having medical conditions which would be directly or indirectly aggravated by exposure to fibrous glass, free silica, dust and asphalt fume, should be counseled on the increased risk of impairment of their health from working with these substances.

d. Those employees exposed to excessive concentration of free silica should have preemployment chest X-rays, and at least once every three years thereafter.

REFERENCES

1. Threshold Limit Values (TLV) for Chemical Substances and Physical Agents in the Workroom Environment for 1977, by the American Conference of Governmental Industrial Hygienists.

2. NIOSH "Criteria for a Recommended Standard ... Occupational Exposure to Alkanes," Department of Health, Education, and Welfare Publication No. (NIOSH) 77-151, 1977.

3. NIOSH "Criteria for a Recommended Standard ... Occupational Exposure to Asphalt Fumes," Department of Health, Education, and Welfare Publication No. (NIOSH) 78-106, 1977.

4. NIOSH "Criteria for a Recommended Standard ... Occupational Exposure to Crystalline Silica," Department of Health, Education, and Welfare Publication No. (NIOSH) 75-120, 1977.

5. Documentation of the Threshold Limit Values for Substances in Workroom Air, Nuisance Dust. American Council of Governmental Industrial Hygienists, 1975. p. 190.

6. Asphalt Hot Mix Emission Study, Research Report 75-1. The Asphalt Institute.

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TABLE 1

TOTAL AND RESPIRABLE PARTICULATES AIR CONCENTRATIONS

HERBERT MALARKEY ROOFING, INC. PORTLAND, OREGON

HHE 76-56

	TYPE OF SAMPLE	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOLUME LITERS	mg/m^3 *
BZ **	Total Particulate	Dry Felt Man	3-1-77	V 1839	420	714	3.65
BZ	Total Particulate	Dry Felt Man	3-2-77	V 1805	400	680	2.78
BZ	Total Particulate	Saturator Man	9-22-77	Ag 46	320	544	2.39
BZ	Total Particulate	Coater Man	9-22-77	Ag 38	392	666	11.86
BZ	Total Particulate	Coater Man	9-22-77	Ag 45	335	570	15.61
BZ	Respirable Particulate	Coater Man	3-22-77	RV 579	360	612	0.46
BZ	Total Particulate	Press Man	9-22-77	Ag 39	388	660	21.97
BZ	Total Particulate	Press Man	9-22-77	Ag 44	320	544	8.27
BZ	Respirable Particulate	Press Man	3-22-77	PV 364	386	656	0.49
BZ	Total Particulate	Granule Man	3-1-77	PV 398	338	575	28.82
BZ	Total Particulate	Granule Man	3-2-77	PV 616	363	617	2.30

(continued)

(continued)

T A B L E 1

	TYPE OF SAMPLE	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOLUME LITERS	mg/m^3
BZ	Respirable Particulate	Slate Man	3-1-77	PV 551	414	704	1.16
GA***	Total Particulate	By Slate Bins	3-2-77	PV 602	359	597	0.47
BZ	Total Particulate	Lead Man	9-22-77	Ag 41	360	612	5.29
BZ	Total Particulate	Cutter Man	3-2-77	V 1817	393	668	0.94
BZ	Total Particulate	Conveyor Man	3-1-77	V 1796	367	624	2.07
BZ	Total Particulate	Conveyor Man	3-2-77	V 1824	380	646	0.58
BZ	Total Particulate	Wrapping Machine Operator	9-22-77	Ag 40	377	641	1.40
	Total Particulate	Wrapping Machine Operator	9-22-77	Ag 47	300	510	0.59
GA	Total Particulate	On 3rd Deck by Door to Slate Bin Above Coater	9-22-77	Ag 43	345	587	112.27
GA	Total Particulate	On 1st Deck Above Coater	9-22-77	Ag 48	345	587	54.68

* mg/m^3 - milligrams of substance per cubic meter of air
** BZ - Breathing Zone
*** GA - General Area

T A B L E 2

BENZO(A)PYRENE (BAP) AIR CONCENTRATIONS
HERBERT MALARKEY ROOFING CO., INC.

PORTLAND, OREGON
HHE 76-56

	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOLUME LITERS	BAP mg/m^3 *
BZ+	Saturator Man	3-1-77	Ag 1	413	413	< 0.12**
BZ	Saturator Man	3-2-77	Ag 12	434	434	< 0.12
BZ	Coater Man	3-1-77	Ag 3	406	406	< 0.12
BZ	Coater Man	3-2-77	Ag 21	360	360	< 0.14
BZ	Press Man	3-1-77	Ag 4	395	395	< 0.13
BZ	Press Man	3-2-77	Ag 14	386	386	< 0.13
BZ	Relief Man	3-1-77	Ag 8	272	462	< 0.11
BZ	Relief Man	3-2-77	Ag 18	329	329	< 0.13
BZ	Lead Man	3-1-77	Ag 6	308	524	< 0.095
BZ	Lead Man	3-2-77	Ag 15	370	370	< 0.14
BZ	Foreman	3-1-77	Ag 7	286	486	< 0.10
BZ	Foreman	3-2-77	Ag 16	370	370	< 0.14
BZ	Cutter Man	3-1-77	Ag 10	318	541	< 0.095
BZ	Fork Lift Driver	3-1-77	Ag 9	280	476	< 0.11
BZ	Wrapping Machine Operator	3-1-77	Ag 5	293	293	< 0.17
BZ	Wrapping Machine Operator	3-2-77	Ag 18	306	306	< 0.13
GA++	On 3rd Deck by Door to Slate Bins Above Coater	3-2-77	Ag 22	255	255	< 0.20

* mg/m^3 - micrograms per cubic meter of air
** Minimum detectable concentration is 0.05 mg/sample
\+ BZ - Breathing Zone
++ GA - General Area

TABLE 3

ASPHALT FUME, CYCLOHEXANE SOLUBLE AIR CONCENTRATIONS

HERBERT MALARKEY ROOFING CO., INC.
PORTLAND, OREGON

HHE 76-56

	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOLUME LITERS	TOTAL PARTICULATES (INCLUDES ASPHALT FUME) mg/m^3 *	CYCLOHEXANE SOLUBLES mg/m^3	ASPHALT FUME (CALCULATED) mg/m^3
BZ+	Saturator Man	9-22-77	Ag 46	320	544	2.39	0.76	2.3
BZ	Coater Man		Ag 38	392	666	11.86	0.21	0.6
BZ	Coater Man		Ag 45	335	570	15.61	1.06	3.2
BZ	Press Man		Ag 39	388	660	21.97	0.54	1.6
BZ	Press Man		Ag 44	320	544	8.27	0.30	0.9
BZ	Wrapping Machine Operator		Ag 40	377	641	1.40	0.77	2.3
BZ	Lead Man		Ag 41	360	612	5.29	0.76	2.3
BZ	Foreman		Ag 42	385	655	-	0.96	2.9
GA++	1st Deck Above Coater		Ag 48	345	587	112.0	6.51	19.5
GA	3rd Deck Above Coater		Ag 43	345	587	54.6	4.45	13.4
GA	Bulk Air Sample Collected in the Saturator		Ag 49	160	272	53.3	16.7	53.3

* mg/m^3 - milligrams of substance per cubic meter of air
\+ BZ - Breathing Zone
++ GA - General Area

T A B L E 4

ALIPHATIC HYDROCARBON AIR CONCENTRATIONS

HERBERT MALARKEY ROOFING, INC.
PORTLAND, OREGON

HHE 76-56

	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOLUME LITERS	TOTAL IDENTIFIED ALIPHATICS mg/m^3 *	UNIDENTIFIED ALIPHATICS mg/m^3	TOTAL ALIPHATICS mg/m^3
BZ+	Saturator Man	3-1-77	C-1	413	413	2.96	3.65	6.62
BZ	Saturator Man	3-2-77	C-12	434	434	6.97	8.99	15.96
BZ	Coater Man	3-1-77	C-3	406	406	0.27	0.24	0.51
BZ	Coater Man	3-2-77	C-21	360	360	0.20	0.28	0.48
BZ	Press Man	3-1-77	C-4	395	395	0.37	0.25	0.67
BZ	Press Man	3-2-77	C-14	386	386	0.67	0.51	1.18
BZ	Wrapping Machine Op	3-1-77	C-5	293	293	0.54	ND**	0.54
BZ	Wrapping Machine Op	3-2-77	C-18	386	386	0.88	0.52	1.40
BZ	Relief Man	3-2-77	C-20	329	329	0.23	ND	0.23
BZ	Lead Man	3-2-77	C-15	370	370	3.75	4.86	8.61
BZ	Foreman	3-2-77	C-16	370	370	0.85	0.81	1.66
GA++	On Third Deck Above Coater	3-2-77	C-22	255	255	8.02	6.67	14.29

* mg/m^3 - milligrams per cubic meter of air
** ND - less than 0.34 mg/m^3
\+ BZ - Breathing Zone Sample
++ GA - General Area Sample

NOTE: Aromatic Hydrocarbons were not detected in the samples.

TABLE 5

AIR CONCENTRATIONS OF IDENTIFIED
INDIVIDUAL ALIPHATIC HYDROCARBONS
FROM TABLE 4

HERBERT MALARKEY ROOFING CO., INC.
PORTLAND, OREGON

HHE 76-56

SAMPLE NUMBER	1,2 Dichloro-ethane ug/m^3 **	N-pentane ug/m^3	N-hexane ug/m^3	N-heptane ug/m^3	N-octane ug/m^3	N-nonane ug/m^3	N-decane ug/m^3	N-undecane ug/m^3	N-dodecane ug/m^3	N-tridecane ug/m^3	N-tetradecane ug/m^3	N-pentadecane ug/m^3	N-hexadecane ug/m^3	TOTAL IDENTIFIED ALIPHATIC HYDROCARBONS mg/m^3 ***
C-1	24	95	98	95	2	171	426	810	547	321	196	139	44	2.96
C-12	18	46	45	30	68	422	1600	2515	1448	459	158	120	44	6.97
C-3	16	58	33	*	21	*	*	34	30	24	23	25	3	0.27
C-21	65	50	33	*	55	*	*	*	*	*	*	*	*	0.20
C-4	16	33	31	38	60	32	39	43	31	22	22	*	*	0.37
C-14	38	23	26	38	55	97	80	100	65	61	40	45	5	0.67
C-5	56	31	19	*	31	259	49	57	38	*	*	*	*	0.54
C-18	824	*	15	*	*	*	*	20	23	*	*	*	*	0.88
C-20	179	15	19	*	*	*	*	21	*	*	*	*	*	0.23
C-15	22	35	28	56	52	184	915	1406	638	175	114	83	39	3.75
C-16	53	34	26	19	51	79	31	115	154	72	70	101	45	0.85
C-22	113	1285	1575	1234	913	651	400	412	303	200	527	300	109	8.02

* less than 1 ug/sample

** ug/m^3 - micrograms per cubic meter

*** mg/m^3 - milligrams per cubic meter

TABLE 6

FREE SILICA AIR CONCENTRATIONS

HERBERT MALARKEY ROOFING CO., INC.
PORTLAND, OREGON

HHE 76-56

	TYPE OF SAMPLE	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOLUME LITERS	PARTICULATES mg/m^3*	EVALUATION CRITERIA *** % FREE SiO_2**	FREE SILICA mg/m^3	OSHA STANDARDS mg of dust/m^3	NIOSH PROPOSED CRITERIA
BZ+	Total Particulate	Coater Man	3-2-77	PV 579	360	612	0.46	< 14.1	< 0.065	< 1.86	-
BZ	Respirable Particulate	Press Man	3-2-77	PV 364	386	656	0.49	< 12.4	< 0.061	< 0.69	0.05 mg of free SiO_2/m^3
BZ	Total Particulate	Granule Man	3-1-77	PV 398	338	575	28.82	6.4	1.843	3.58	-
BZ	Total Particulate	Granule Man	3-1-77	PV 616	363	617	2.30	< 2.8	< 0.065	< 6.25	-
BZ	Respirable Particulate	Slate Man	3-1-77	PV 551	414	704	1.16	< 4.8	< 0.057	< 1.47	0.05 mg of free SiO_2/m^3
GA‡	Total Particulate	By Slate Bins	3-2-77	PV 602	359	597	0.47	< 14.3	< 0.067	< 1.84	-

* Milligram of substance per cubic meter of air

** Limit of Detection - 0.04 mg/sample

*** The OSHA Standards for Silica-bearing dust is based on the % free silica in the sample and is calculated as follows:

TOTAL DUST $\dfrac{30}{\%\ \text{free}\ SiO_2 + 2}$

RESPIRABLE DUST $\dfrac{10}{\%\ \text{free}\ SiO_2 + 2}$

\+ BZ - Breathing Zone

‡ GA - General Area

T A B L E 7

FREE SILICA AND ASBESTOS BULK SAMPLE

HERBERT MALARKEY ROOFING CO., INC.
PORTLAND, OREGON

HHE 76-56

SAMPLE NUMBER	DESCRIPTION	% FREE SILICA
1	Light Brown Granules	26
2	Green Granules	25
3	Headlap Granules	30
4	Tan Granules	28
5	Rep Granules	30
6	White Granules	29
7	Dark Brown Granules	32
8	Mica	9
9	Talc	0.2
10	Coo Sand	60

		% Asbestos
9	Talc	None Detected

T A B L E 8

EMPLOYEE RESPONSE TO SUBSTANCES PRESENT

HERBERT MALARKEY ROOFING CO., INC.

PORTLAND, OREGON

HHE 76-56

	March 1 13 workers	March 2 12 workers	September 22 10 workers
Eyes irritated Post Shift	1 slight	None	None
Redness of eyes Scale 0-3, change Pre to Post Shift	1-0 to 1	5-0 to 1/2 1-0 to 1	None
Lacrimation Scale 0-3, Change Pre to Post Shift	2-0 to 1/2 3-0 to 1	2-0 to 1/2	None
Throat Irritation	None	None	None
Throat Dry Pre to Post Shift	5	3	4
Nose irritated Pre to Post Shift	None	1 slight	1 slight
Nose Dry Pre to Post Shift	6	6	3
Skin itch Pre to Post Shift	3	1	-

11 out of 11 stated their skin itched when fibrous glass was run.

6 out of 11 stated that their skin itched when felt impregnated with fibrous glass was run.

TABLE 9

SPECIFIC POLYNUCLEAR AROMATIC HYDROCARBON AIR CONCENTRATIONS

HERBERT MALARKEY ROOFING CO., INC.
PORTLAND, OREGON

HHE 76-56

	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOLUME LITERS	BENZO(A)PYRENE ng/m³*	BENZ(A)ANTHRACENE ng/m³	CHRYSENE ng/m³	FLUORANTHENE ng/m³	PYRENE ng/m³
BZ+	Saturator Man	9-22-77	Ag 46	320	544	ND**	ND	ND	ND	ND
BZ	Coater Man		Ag 38	392	666	ND	ND	ND	ND	ND
BZ	Coater Man		Ag 45	335	570	ND	ND	ND	ND	ND
BZ	Press Man		Ag 39	388	660	ND	ND	ND	ND	ND
BZ	Press Man		Ag 44	320	544	ND	ND	ND	ND	211
BZ	Wrapping Machine Operator		Ag 40	377	641	ND	ND	56	47	ND
BZ	Lead Man		Ag 41	360	612	ND	ND	ND	46	ND
BZ	Foreman		Ag 42	385	655	ND	ND	ND	ND	ND
GA++	1st Deck Above Coater		Ag 48	345	587	187	43	167	324	239
GA	3rd Deck Above Coater		Ag 43	345	587	114	273	222	647	664
GA	Bulk Air Sample Collected in the Saturator		Ag 49	160	272	3235	***	2059	9190	6985

\+ BZ - Breathing Zone
++ GA - General Area
* ng/m³ - Nanograms of substance per cubic meter of air
** ND - Not Detectable, Limit of Detection is: benzo(a)pyrene - 11 ng/sample; benz(a)anthracene - 12 ng/sample
chrysene - 30 ng/sample; fluoranthene - 26 ng/sample; pyrene - 60 ng/sample
*** Due to Interferences the benz(a)anthracene could not be determined.