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 76-54-436
CERTAIN-TEED PRODUCTS, INC.
RICHMOND, CALIFORNIA

OCTOBER 1977

I. TOXICITY DETERMINATION

It has been determined that at the Certain-Teed Plant, Richmond, California:

1) Employees working in and around the coater line for roofing shingles were exposed to excessive concentrations of limestone and other nuisance dusts. This determination is based on the fact that dust levels measured at the coater line during NIOSH's investigation (September 29-30, 1976) were excessive in terms of the criteria (ACGIH Threshold Limit Value) used for this study.

2) Employees working in the slate room and areas near the slate operation were exposed to potentially toxic concentrations of the dust which contained crystalline silica. This determination is based on the fact that dust concentrations measured in these areas during NIOSH's investigation (September 29-30, 1976) were high in terms of the criteria used for this study.

3) Exposures to benz(a)pyrene, other polynuclear aromatics (PNA's), and α and β naphthylamine, aliphatic hydrocarbons, benzene, and other aromatic hydrocarbons were not toxic. This determination is based on the low levels measured or the absence of these compounds in the samples taken during NIOSH's investigation.

4) Employees' exposures to asphalt fumes could not be adequately characterized to make a determination of toxicity with the currently acceptable sampling and analytical methods. General recommendations are included in this report to minimize employees' exposures to asphalt fumes.

5) Fibrous glass fiber and formaldehyde exposures could not be measured since this product was not processed during NIOSH's visit and is run infrequently.

6) There were only signs of irritation 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 follow-up.

The above determinations and conclusions were made concerning the major processes and air contaminants that employees were exposed to at the Certain-Teed Products Corporation plant. Detailed information concerning the above determinations are contained in the body of the report. Recommendations are included in Section V of this report. The final report has taken an extra amount of time to complete.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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:

(a) Certain-Teed Products, Inc., Richmond, California

(b) U.S. Department of Labor, Region IX

(c) CAL/OSHA

(d) NIOSH, Region IX

(e) Authorized Representative of Employees - International Union of the United Paperworkers

For the purpose of informing the approximate 50 affected employees, the employer will post the report in a prominent place(s) accessible to the employees for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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 (NIOSH) received such a request from the United Paperworkers International Union, Flushing, New York, to determine whether materials used in the production of asphalt shingles and rolled roofing materials are toxic in the concentrations used or found at the Certain-Teed Products Corporation plant, Richmond, California. The materials involved are paper felt, fibrous glass, formaldehyde, asphalt (petroleum), colored granules, limestone, talc, and mica.

IV. HEALTH HAZARD EVALUATION

A. Description of Plant Process

The main roofing line at the Richmond Certain-Teed plant produces asphalt shingles which have cores made of either paper felt (matte) or fibrous glass. When the core is felt, it is fed from continuous rolls through a series of accumulation loops before entering the asphalt "saturator." In the saturator, hot petroleum liquid asphalt which has been heated to approximately 400°F is applied to the felt as it goes through another series of loops. When the felt leaves the saturator, it has been completely saturated with asphalt. The saturated felt then passes through a baffle of liquid asphalt which has been thickened with limestone. This bath and baffle system is known as the "coater." When the fibrous glass core is run on the production line, the fibrous glass matte is shunted around the saturator and is fed directly into the coater. At the coater, the asphalt is spread and pressed on the matte with rollers and is passed to the "press area" where colored granules are dropped and pressed into the asphalt. After the granules have been placed on the matte, a mixture of talc and mica is applied to the back side of the material to prevent sticking. The material then passes through a water spray and another series of cooling and accumulation loops. A thin stream of liquid asphalt is applied to the matte in an operation called "seal down" as it leaves the cooling loops and proceeds to the final steps (cutting, stacking, wrapping, and storage).

Two shifts were in operation at the time of the survey (September 29-30, 1976) and approximately 12 employees can handle the main shingle (coater) line. Two employees handle the slate granules and other minerals used in the shingles. The "slateman" and his assistant are responsible for monitoring the flow of granules and for loading talc and mica into ventilated hoppers from bags. The hoppers are located in close proximity to the coater and the slateroom is above the coater. Also, during the time

of the survey, the limestone "filler-heater" was located in the area of the coater. The limestone is heated to drive off as much residual moisture as possible and is blown into a mixer where it is added to the asphalt for the coater. The filler-heater caused an excess amount of dust to be present in the entire coater area of the plant. Certain-Teed, however, was in the process of relocating the filler-heater outside of the building in response to a CAL/OSHA action.

At the Richmond plant, engineering constrols designed to limit the amount of asphalt fumes and dust being emitted into the workplace atmosphere were not ideal. The saturator, was, for the most part, enclosed and under some negative pressure. The talc and mica dumping bins were equipped with local exhaust ventilation. The coater area did not have effective ventilation and neither did the slate room. An effective respirator program was not being enforced at the time of NIOSH's survey. Therefore, exposures to workers from various contaminants at the shingle line do occur. Each operation has a worker assigned to it and his exposure will be mainly to the substances in the area.

Exposures to asphalt fumes can occur in the coater area and in the saturator. Employees enter the saturator whenever there is a break in the continuous matte or for other malfunctions. Although this exposure is not continuous, workers are exposed to concentrated levels of asphalt fumes. No respiratory protection is worn by workers in the saturator. At the coater, the coaterman is exposed to concentrated levels of asphalt fumes if he works directly over the coater. However, the coaterman rotates throughout the coater area where levels of asphalt fumes are much lower than directly over the coater.

Workers in and around the coater area were also exposed to high levels of limestone dust from the filler-heater. The slateman and his assistant were included in this group of exposed workers. Additionally, the slate handlers were exposed to crystalline silica because they worked with the colored granules in the slate room.

Despite its occasional use, fibrous glass could not be evaluated during this survey. Whenever fibrous glass product was processed, workers complained about eye, throat, and skin irritation. It was hypothesized that the eye and throat irritation was caused by the residual formaldehyde in the fibrous glass matte. The formaldehyde was apparently being released into the atmosphere when hot asphalt contacted the matte.

Two smaller operations were present at Certain-Teed in addition to the main shingle line. These were the asphalt felt line where rolled roofing products were made and the "Hallmark" line. The asphalt felt line is handled by three employees. Paper felt goes directly through a small saturator and the final product is cooled and rolled. The Hallmark operation is handled by about eight employees. Here, small strips of cut shingle are glued to the top of a regular shingle with hot asphalt. Asphalt fumes are generated at the point of operation but local exhaust ventilation is present. All the

workers rotate throughout the day, so exposures to asphalt fumes are not continuous.

B. Evaluation Methods

1. Environmental

Methods for the evaluation of the work environment varied and was dependent upon the substances the employees were exposed to during the work shift. The methods for the particular contaminant are described below:

Asphalt (petroleum) fume - asphalt fume samples were collected with MSA Model G battery powered personal sampling pumps. The sampling cassettes held tared (pre-weighed) silver membrane and glass fiber filters. The cassettes were placed on workers' lapels for breathing zone samples and in the work area for general area samples. The flow rates were 1.0 or 1.7 liters per minute. The lower flow rate was necessary since charcoal tubes were used in combination with filters on some of the samples. The particulates (which included fumes and dust) were extracted with cyclohexane and the soluble fraction was determined. It was assumed that the soluble fraction represented the amount of asphalt collected on the filters. The cyclohexane soluble fraction was in turn analyzed for benz(a)pyrene (BAP) and other polynuclear aromatics (PNA's) such as chrysene, phenanthrene, pyrene and anthracene using a liquid chromatograph.

Asphalt volatiles - asphalt volatile samples were collected with the same MSA pumps using charcoal or silica gel tubes which were preceded by the silver membrane - glass fiber filters. The flow rate was 1.0 liters per minute. The aromatic hydrocarbons and the aliphatic hydrocarbons present on the charcoal tubes were analyzed for using gas chromatographic techniques. α and β naphthylamine, benz(a)pyrene, and other PNA's, if present on the silica gel tubes, were analyzed with a liquid chromatograph.

Dust - dust and other particulates were sampled using the same MSA pumps and various filters. Tared vinyl metricel or polyvinyl chloride (FWS-B) filters were used for gravimetric dust samples. Flow rates were 1.7 liters per minute. Crystalline silica samples were collected on polyvinyl chloride filters. The majority of the silica samples were respirable samples and the filters were used in combination with 10 mm cyclones. The flow rates were 1.7 liters per minute. Total particulate concentrations were also determined from the tared silver membrane and glass fiber filters, but these results may contain weighing errors due to the fact that the filters may pick up moisture. Silica analysis was accomplished by X-ray diffraction.

Formaldehyde - personnel or general area samples over a time period were not collected for formaldehyde because fibrous glass shingles were not processed. In the fibrous glass matte storage area, ambient formaldehyde levels were surveyed using Draeger length-of-stain detector tubes.

2. Medical

A non-directed medical questionnaire containing identification data, smoking history, occupational health, and complaints relating to work were administered to a sample of nine workers during the initial visit on July 7, 1976. All of the responses to the questionnaire were as might be expected for reactions to fibrous glass exposure. Skin, eye, nose, and throat irritation were common when fibrous glass product was processed. It was decided by NIOSH that a physician would not be assigned to the follow-up survey since no unusual findings were uncovered from the preliminary questionnaire. However, during the follow-up survey, a short questionnaire asking workers to describe their own feelings about eye, nose, throat, and skin irritation was administered pre and post shift. Additionally, a visual inspection of the redness and degree of wateriness of the eyes was made pre and post shift by the NIOSH investigators.

C. Evaluation Criteria

1. Environmental Standards or Criteria

The two primary sources of environmental evaluation criteria used for this report were the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) for Chemical Substances and Physical Agents in the Workroom Environment for 1976 and NIOSH Criteria Documents for Recommended Occupational Exposure to Benzene (Revised Recommendation), Formaldehyde, and Crystalline Silica. These criteria are discussed below:

Asphalt (Petroleum) Fume - the ACGIH recommended TLV for asphalt fume is 5.0 mg/m^3 (milligrams of substance per cubic meter of air) based on a time-weighted average (TWA) over a work shift. No NIOSH recommendation or a U.S. Department of Labor Standard for asphalt fume existed at the time of this survey.

Dust (Nuisance) - the ACGIH TLV for nuisance dust which includes mica, non-asbestos form talc, limestone, felt dust, etc., is 10 mg/m^3 (total dust) based on a TWA over a work shift. The U.S. Department of Labor Standard for nuisance dust is 15 mg/m^3 (total dust) based on a TWA over a work shift. For the respirable dust fraction, each limit above drops to 5 mg/m^3 based on a TWA over a work shift.

Crystalline Silica[1]- the NIOSH recommended limit for crystalline silica in respirable samples based on a TWA over a work shift is 0.050 mg/m^3 regardless of the form of the crystalline silica. The U.S. Department of Labor Standard for the respirable fraction of crystalline silica based on a TWA over a work shift is calculated by the following formula: $\frac{10\ mg/m^3}{\%SiO_2 + 2}$. The ACGIH recommended limit for the respirable fraction is calculated with the same formula. The ACGIH recommended limit or TLV for crystalline silica when a total dust sample is collected is calculated from the following formula: $\frac{30 mg/m^3}{\%SiO_2 + 3}$.

Benzene - the NIOSH revised recommendation for benzene is a maximum exposure of 1.0 parts per million (ppm) or 3.2 mg/m^3 at any time.[2]

Formaldehyde - the NIOSH recommendation for formaldehyde exposure is a ceiling concentration of 1.0 ppm or 1.2 mg/m^3 based on a 30-minute sampling period. The ACGIH TLV for formaldehyde is a ceiling concentration of 2.0 ppm.

Criteria for other substances in this investigation with no current limits or found only in trace amounts will be discussed in the results section of this report.

2. Medical Standards or Criteria

The adverse effects from expousre to the substances evaluated in this investigation depend upon the degree and length of exposure. These effects are described below:

Asphalt (Petroleum) Fume - asphalt fume contains a large number of organic chemicals. Many of the chemicals are present only in trace amounts and may even be undetectable by the standard methods of analysis. Asphalt fume contains condensed particles composed of long chain complex high boiling hydrocarbons. It also contains hydrocarbons that are vapors at room temperature. These vapors may include the aliphatic hydrocarbons C-8 through C-16 and certain aromatic hydrocarbons such as benzene. Benzene may be present in small quantities depending on the source and batch of the purchased asphalt. Heating of asphalt may generate into the atmosphere such polynuclear aromatic (PNA) compounds as anthracene, chrysene, phenanthrene, pyrene, and benz(a)pyrene. Benz(a)pyrene is considered as a carcinogen. In general, the components of petroleum asphalt fume present in high enough quantities may produce narcotic effects and eye, nose, and throat irritation.

Benzene - benzene has been recognized as a toxic substance capable of causing acute or chronic effects. Inhalation is the primary route of entry of benzene into a person. It diffuses rapidly through the lungs and is quickly absorbed into the blood. Benzene exerts a primary toxic effect in the bone marrow which is the major blood forming organ. Long-term exposures to low concentrations of benzene have been observed to have an initial stimulatory effect on the blood forming bone marrow followed by asplasia (no cell production) and fatty degeneration. Clinically an initial increase, then decrease, in the red blood cells, white blood cells, or platelets is seen with progression (if exposures continue) to aplastic anemia (lack of functioning of bone marrow), leucopenia (decrease in white blood cells), thrombocytopenia (decrease in platelets), or pancytopenia (decrease in all cells in the peripheral blood). Additionally, NIOSH has concluded that benzene has the potential for causing leukemia.[2] This clinical picture of chronic benzene poisoning may exist with or without the physical signs or symptoms of fatigue, vertigo, headache or excessive bleeding.

Formaldehyde - the major effect of exposure to formaldehyde in air is local irritation of the eyes, nose, and throat. Also, the perception of formaldehyde by odor has been shown to become less sensitive with time as adaptation occurs. Additionally, exposure to formaldehyde may cause sensitization in exposed individuals resulting in irritation complaints, disturbing odor,

and disturbed sleep at 1 to 2 ppm.[3]

Nuisance Dusts - nuisance dusts have been shown to have little adverse effects on the lungs and do not produce significant disease or toxicity when exposures are kept under reasonable control. These dusts such as limestone, mica, paper dust, and non-asbestos form talc are considered to be 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.[4] Excessive concentrations in the work area may reduce visibility, cause unpleasant accumulations in the eyes, ears, nose, and throat, and secondarily may cause injury to the skin due to vigorous cleansing procedures necessary for their removal.

Crystalline Silica - finely divided silica in the free state can cause silicosis, a fibrotic lung disease. This form of pneumoconiosis usually occurs after a number of years of exposure, although, it can occur in a short time with severe exposures. The acute form may be recognized after eight to 18 months of 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 without showing much functional impairment in the individual. 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 the exposure and incapacitates the affected person. Prevention is extremely important since treatment is not effective.

D. Evaluation Results and Discussion

1. Environmental Results

A) Asphalt Fumes

Eighteen samples were collected for asphalt fumes and the results are contained in Table III. These samples contained asphalt fumes plus any other particulates such as dust that were collected on the filters. In the laboratory, when asphalt pitch was dissolved in cyclohexane, all of it was soluble. However, when bulk air samples were collected in the saturator where most of the particulate was expected to be asphalt fume, less than 20 percent of the material on the filter was soluble. Based on this result, it is impossible to say that the cyclohexane soluble fraction found in the 18 samples was all of the asphalt fume in the sample. However, the standard analysis for the cyclohexane soluble fraction is considered in itself to be fairly reliable. Four of the samples had cyclohexane soluble fractions in excess of the total weight concentrations on the filters. NIOSH laboratory personnel had no good explanation for this error other than stating that weighing error may have produced this result. Hundreds of filters are weighed and labeled in advance and are sent into the field upon request. A mix-up may have occurred. Also, the questions surrounding the analytical method may have resulted in this error.

In analyzing the results in Table III, if it is assumed that the cyclohexane soluble fraction concentrations are correct, all of the samples contained levels less than 5.0 mg/m^3 (the TLV for asphalt fumes). The range of levels was from 0.24 - 3.26 mg/m^3 and the average was 1.02 mg/m^3. However, it must be remembered that less than 20 percent of the bulk air samples could be dissolved in cyclohexane. The ambient dust at the coater line was extremely high from the filler-heater, and this fact was evident by looking at the total particulate (weight) concentrations on the eight samples collected on the coater line. Seven of the eight samples showed particulate concentrations in excess of the ACGIH TLV of 10 mg/m^3 for nuisance dust and six samples were above 15 mg/m^3 (the U.S. Department of Labor Standard for nuisance dust). The other 10 samples were collected in less dusty areas and the total weight concentrations were well below the 10 milligram level.

Therefore, in conclusion, no definite statement can be made concerning the asphalt fume exposures of the workers at Certain-Teed when the sampling and analysis was done using the methods devised by NIOSH for the Certain-Teed investigation. NIOSH is currently revising its sampling and analytical method for asphalt fumes as a result of the difficulties encountered in this study. However, if a judgment is to be made, it seems that the asphalt fume exposures of the workers seems to be below 5.0 mg/m^3, but how far below cannot be answered.

Table IV contains the aliphatic hydrocarbon levels found in the charcoal tube samples taken in conjunction with the asphalt fume samples. A total of six aliphatic hydrocarbons were isolated (heptane, octane, nonane, decane, undecane, and dodecane): C-7 to C-12. Other longer chain hydrocarbons could not be differentiated. The total aliphatic hydrocarbon concentrations listed in Table IV include C-7 to C-12 and all of the unidentified ones. In NIOSH's Criteria Document for the Alkanes C-5 to C-8, it is recommended that exposures be limited to 350 mg/m^3 based on a TWA for a work shift.[5] No NIOSH criteria exists for hydrocarbons above C-8 although the ACGIH lists TLV's for nonane, C-9, at 1,050 mg/m^3 as well as some of the lower carbon numbers. Generally, the longer the carbon chain for these aliphatic hydrocarbons, the less toxic the compound. In any event, if all of the aliphatic hydrocarbons found in the samples were grouped together and considered to be as toxic as the alkanes (C-5 to C-8) with a limit of 350 mg/m^3, the highest level found in any of the Certain-Teed samples was 12.56 mg/m^3. The range was 2.40 - 12.56 mg/m^3. Thus, the aliphatic hydrocarbon levels at Certain-Teed were extremely low.

The aromatic hydrocarbons, especially benzene, were sampled for in the work areas using charcoal tubes. No aromatics could be found, and therefore, are not listed in a table. A total of 13 charcoal tube samples were taken, but one sample was lost during analysis.

Samples were taken for benz(a)pyrene (BAP) and other polynuclear aromatics (PNA's). The samples were taken on 18 silver membrane filters and five silica gel tubes. Three of the samples were collected in the saturator and were bulk air samples. No BAP or other PNA's were detected in any of the samples. The limit of detection for BAP was less than 0.05 ug (micrograms) per sample. The limit of detection for other PNA's was less than 2 ug per sample.

The five silica gel samples were also analyzed for α and β naphthlyamines. Two of the samples could not be analyzed due to the lack of separation and specificity. The other three could be analyzed and no α and β naphthlyamine could be detected. The limit of detection for these two substances is 1.0 ug per sample. Additionally, no PNA's were detected on the silica gel tubes.

In conclusion, polynuclear aromatics including BAP did not constitute a health hazard at Certain-Teed based on the results of the samples taken on September 29-30, 1976, using the current NIOSH sampling and analytical methods. Also, α and β naphthlyamines did not represent a health hazard based on the samples taken with silica gel tubes on September 29-30, 1976.

B) Total and Respirable Dust (Including Crystalline Silica)

Table I contains the results of dust samples collected on vinyl metricel filters. Two general area samples were taken at the Hallmark line. The total dust concentrations were 0.36 and 2.35 mg/m^3. These levels are well below the ACGIH TLV of 10 mg/m^3 for nuisance dusts. Two breathing zone samples were collected on the felt man on the asphalt felt (saturator) line. The total dust levels were 0.64 and 1.69 mg/m^3 which were well below the ACGIH 10 mg/m^3 limit. Two breathing zone samples were taken on the felt man on the coater line. The results were 4.95 and 60.56 mg/m^3. The difference in these two results are huge and could be dismissed, but the dust exposure can vary widely day-to-day and depends upon the amount of time spent in the coater area where the dust levels are extremely high. Four samples were taken in the general area of the coater. These results were 7.56, 18.60, 61.35, and 90.01 mg/m^3. Three of the results are well above the ACGIH limit of 10 mg/m^3. Thus, it seems that workers on the coater line can be exposed to excessive nuisance dust levels. Six of the asphalt fume samples tended to support this conclusion as discussed above in the results for asphalt fumes.

Table II contains the results of five samples for crystalline silica. Two respirable samples were taken on the slateman over a two-day period. The respirable dust levels found were 3.12 and 7.85 mg/m^3. The calculated TLV for these samples based on the amount of crystalline silica in the samples were respectively 2.22 and 2.4 mg/m^3. Thus, the dust exposures to the slateman exceeded the calculated limits. Also, the crystalline silica concentrations exceeded the NIOSH recommended limit of 50 ug/m^3. Two respirable samples were taken on the coaterman. The dust levels were 5.96 and 2.74 mg/m^3. The respective calculated TLV's were 2.2 and 5.0 mg/m^3. Therefore, one out of the two samples was in excess of the

calculated limit. The silica level in this sample was also above the NIOSH recommended limit. One total dust sample for crystalline silica was taken on the press roll man. The total dust concentration was found to be 27.6 mg/m^3 and the calculated TLV was 8.11 mg/m^3 based on the percent of crystalline silica in the sample. The NIOSH recommended limit does not apply since it is only based on respirable samples. Thus, based on the samples taken on September 29-30, 1976, crystalline silica represent a dust hazard in the immediate area of the coater and in the slate room. A letter noting the potential health hazard from crystalline silica was sent to the plant manager of Certain-Teed on February 11, 1977.

In conclusion, both nuisance dust and crystalline silica represent excessive dust levels on the coater line with silica representing a potential health hazard. This determination is based on the samples collected during this investigation. The filler-heater is the cause of most of the limestone dust being in the coater area of the plant. There is construction now to relocate the filler-heater outside of the building. This construction change should alleviate the nuisance dust problem at the coater line.

C) Formaldehyde

Formaldehyde samples could not be taken on the coater line since fibrous glass product was not processed during NIOSH's visit and is run infrequently. However, the storage area for fibrous glass rolls did have some residual formaldehyde in the air. Using Draeger length-of-stain detector tubes, the formaldehyde levels ranged from 1 - 8 ppm depending upon the place the samples were taken. The storage area is located in a separate building where no one works. However, during loading and unloading of fibrous glass rolls, workers can be exposed to short-term formaldehyde levels of over 1 ppm. These exposures run only for a few minutes.

2. Medical Results

Eight men at the Hallmark line were asked for their own perceptions of itching eyes, dry or irritated nose, and dry or irritated throat both pre and post shift. Three out of eight stated that their eyes were itching slightly post shift. Two out of eight stated that their throats were dry post shift. No other signs of irritation were perceived by these workers. Four out of eight workers exhibited a mild redness of the conjunctiva which was not present during the pre shift examination. These observations were made by the NIOSH investigators who are not physicians.

Two workers were observed on the asphalt felt line. No changes were noted from pre shift examinations during the post shift questions. Six workers were observed on the coater line. One out of six stated that his eyes were itching post shift. Two out of six stated that their noses were irritated and three out of six felt that their throats were irritated post shift. Two out of six exhibited post shift wateriness of the eyes but none had any redness of the conjunctiva. No other signs of irritation were noted.

None of the employees interviewed expressed having sensitivity to sunlight on their skin or signs of skin irritation. Most of the workers felt that when fibrous glass was processed, skin and eye irritation was a problem. In reviewing the medical data, the responses were not unexpected because of the amount of dust and other particulates in the workplace atmosphere, but the results seem to reflect irritation effects and not anything more serious. A more definitive conclusion must be made by a physician.

E. Conclusions

It has been determined that exposures of employees to nuisance dust and other particulates on the coater line are excessive. This determination is based on the dust levels collected in samples on September 29-30, 1976. It has also been determined that crystalline silica exposures to employees in the slate room and around the coater are potentially toxic. This determination is based on the crystalline silica samples collected in these areas on the same dates. It has also been determined that employees' exposures to PNA's including benz(a)pyrene, α and β naphthylamine, aliphatic hydrocarbons, and aromatic hydrocarbons are not toxic. This determination is based upon the fact that only trace amounts of aliphatic hydrocarbons could be found in the samples and none of the other compounds could be detected. Formaldehyde and fibrous glass exposures on the shingle manufacturing line could not be evaluated since these substances were not in the work place during NIOSH's investigation. No definite determination could be made concerning asphalt fumes as explained in the body of the report. The difficulties with the analysis of asphalt fume samples resulted in the delay with this final report.

V. RECOMMENDATIONS

On the basis of NIOSH's investigation of the Certain-Teed plant, the following recommendations are made:

1. Provide local exhaust ventilation on all slate transfer points in the slate room.

2. After the engineering controls have been made in the slate room, crystalline silica samples should be collected again in the slate room and all areas below the slate room on the coater line.

3. After the filler-heater is removed from the building as planned, dust samples should be taken to determine whether nuisance dust levels meet the limits.

4. Certified respirators should be worn by workers until engineering changes have been made and a respirator program meeting requirements of CAL/OSHA should be instituted and be under management supervision.

5. Compressed air should not be used to blow dust out of equipment; vacuuming is preferred. If the material cannot be removed except with compressed air, NIOSH certified respirators should be worn.

6. Local exhaust ventilation should be provided at the coater.

7. 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.

8. Periodic medical examinations should be performed on all personnel exposed to high dust, crystalline silica, and asphalt fume levels. The examinations should include X-rays and pulmonary function tests.

9. Whenever fibrous glass product is run, disposable coveralls are suggested for use by workers. Also, the sleeves, legs, and neck openings should be taped tight against the skin. It is also desirable to change and wash the clothing worn under the coveralls at the end of each shift. Showering post shift is also recommended.

10. Formaldehyde levels should be checked when fibrous glass is run, and if the criteria are exceeded, ventilation should be improved or installed, or a fibrous glass matte with better curing should be used.

VI. REFERENCES

1. NIOSH: "Criteria for a Recommended Standard ... Occupational Exposure to Crystalline Silica," Department of Health, Education, and Welfare Publication No. (NIOSH) 75-120, 1974.

2. NIOSH: "Criteria for a Recommended Standard ... Occupational Exposure to Benzene," Department of Health, Education, and Welfare Publication No. (NIOSH) 74-137, 1974; revised August 25, 1976.

3. NIOSH: "Criteria for a Recommended Standard ... Occupational Exposure to Formaldehyde," Department of Health, Education, and Welfare Publication No. (NIOSH) 77-126, 1977.

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

5. NIOSH: "Criteria for a Recommended Standard ... Occupational Exposure to Alkanes (C-5 to C-8)," Department of Health, Education, and Welfare Publication No. (NIOSH) 77-151, 1977.

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TABLE I. TOTAL PARTICULATE (DUST) CONCENTRATIONS IN MILLIGRAMS PER CUBIC METER (mg/m^3) BY JOB OR LOCATION FROM AIR SAMPLES COLLECTED ON SEPTEMBER 29-30, 1976, WITH VINYL METRICEL FILTERS AT THE CERTAIN-TEED PRODUCTS CORPORATION PLANT, RICHMOND, CALIFORNIA.

SAMPLE#	JOB OR LOCATION	TYPE OF SAMP[1]	DATE	SAMP TIME	SAMP VOL	CONC[2]
V-2309	hallmark line	general area	9/29	338 min.	338 liters	0.36 mg/m^3
V-10	" "	" "	9/30	425 "	425 "	2.35 "
V-2270	felt man coater line	breathing zone	9/29	318 "	541 "	4.94 "
V-853	" " saturator "	" "	9/29	327 "	556 "	1.69 "
V-2252	" " " "	" "	9/30	412 "	700 "	0.64 "
V-2245	felt man coater line	" "	9/30	421 "	716 "	60.56 "
V-2289	coater area	general area	9/29	255 "	434 "	7.56 "
V-2337	" "	" "	9/30	405 "	688 "	18.60 "
V-2282	" control panel	" "	9/29	255 "	434 "	90.01 "
V-2243	" " "	" "	9/30	402 "	683 "	61.35 "

1 - general area samples were placed in one work area and breathing zone samples were placed on the lapel of the worker.
2 - total dust concentrations were expressed in total milligrams of dust per cubic meter of sampled air.

TABLE II. PERCENT FREE SILICA (SiO_2), CALCULATED THRESHOLD LIMIT VALUES (TLV's), AND RESPIRABLE OR TOTAL DUST CONCENTRATIONS IN MILLIGRAMS PER CUBIC METER FROM AIR SAMPLES COLLECTED DURING SEPTEMBER 29-30, 1976, AT THE CERTAIN-TEED PRODUCTS CORPORATION PLANT, RICHMOND, CALIFORNIA.

SAMP#	JOB OR LOCATION	TYPE[1]	DATE	TIME	VOLUME	$\%SiO_2$	CALC. TLV[2]	DUST CONC.[3]
PV420	coaterman	R	9/29	312 min	530 liters	2.2	2.38 mg/m^3	5.96 mg/m^3
PV448	slateman	R	9/29	300 "	510 "	2.5	2.22 "	3.12 "
PV426	press roll man	T	9/29	309 "	525 "	0.7	8.11 "	27.62 "
PV430	coaterman	R	9/30	410 "	697 "	0.0	5.00 "	2.74 "
PV429	slateman	R	9/30	375 "	638 "	2.4	2.27 "	7.85 "

1 - respirable (R) samples were collected in the breathing zones of workers using particle sizing samplers and total dust (T) samples were taken without these samplers.
2 - TLV's were calculated from formulas based on the percent free silica in the sample and whether a respirable or total dust sample was collected.
3 - dust concentrations were actual dust levels measured on the filter sample.

TABLE III. TOTAL WEIGHT LEVELS AND CYCLOHEXANE SOLUBLE FRACTIONS IN MILLIGRAMS PER CUBIC METER FROM SILVER MEMBRANE FILTER SAMPLES COLLECTED ON SEPTEMBER 29-30, 1976, AT THE CERTAIN-TEED PRODUCTS CORPORATION PLANT, RICHMOND, CALIFORNIA.

SAMPLE#	JOB OR LOCATION	DATE	SAMP. TIME	VOLUME	TOT. WEIGHT[1]	CYCLOHEXANE SOLUBLES[2]
S-1	tab man-hallmark line	9/29	338 min.	338 liters	1.48 mg/m^3	0.44 mg/m^3
S-2	" " "	"	336 "	571 "	0.38 "	1.27 " *
S-3	laborer " "	"	335 "	335 "	0.48 "	0.24 "
S-4	" " "	"	333 "	566 "	5.18 "	0.34 "
S-12	tab man " "	9/30	430 "	430 "	1.53 "	3.26 " *
S-13	" " "	"	430 "	731 "	0.95 "	0.70 "
S-14	laborer " "	"	426 "	426 "	0.59 "	0.77 " *
S-15	" " "	"	426 "	724 "	0.81 "	1.39 " *
S-7	sat. op.-coater line	9/29	316 "	316 "	7.62 "	1.25 "
S-8	clean-up " "	"	298 "	298 "	32.18 "	0.87 "
S-9	woodtex tender	"	302 "	302 "	17.05 "	1.42 "
S-10	leadman-coater line	"	306 "	306 "	15.30 "	0.66 "
S-5	sat. op.-asph. line	"	325 "	325 "	1.45 "	0.67 "
S-16	sat. op.-coater line	9/30	417 "	417 "	10.31 "	0.76 "
S-17	clean-up " "	"	397 "	397 "	17.73 "	0.87 "
S-18	press roll op." "	"	406 "	406 "	23.72 "	1.44 "
S-20	leadman-coater line	"	392 "	392 "	29.00 "	1.06 "
S-19	sat. op.-asph. line	"	423 "	423 "	5.30 "	1.04 "

1- total weights in milligrams of substance per cubic meter of sampled air were determined by pre-weighing the filter and back-up pads and weighing them after the sampling.

2- filters and back-up pads were extracted in cyclohexane and a portion of the liquid was evacuated to dryness to determine the portion on the filter and pad that was soluble in cyclohexane.

* the concentrations exceeded the total weight levels on the filters; an explanation is contained in the text of the report.

TABLE IV. TOTAL ALIPHATIC HYDROCARBON LEVELS AND INDIVIDUAL ALKANE CONCENTRATIONS IN MILLIGRAMS PER CUBIC METER BY JOB OR LOCATION FROM CHARCOAL TUBE SAMPLES COLLECTED ON SEPTEMBER 29-30, 1976 AT THE CERTAIN-TEED PLANT, RICHMOND, CA.

SAMPLE#	JOB OR LOCATION	DATE	SAMP. TIME	HE[1]	OC[2]	NO[3]	DE[4]	UN[5]	DO[6]	TOT. ALIPHATIC HC[7]
C-1	tab man-hallmark line	9/29	338 min	0.10	0.33	0.71	0.27	0.69	0.08	5.92 mg/m^3
C-3	laborer "	"	335 "	0.09	ND*	1.22	0.95	0.58	ND	7.76 "
C-5	saturator op. asph. line	"	325 "	0.12	0.37	0.97	0.18	0.75	0.08	7.38 "
C-7	" op. coater line	"	316 "	0.09	ND	0.90	0.58	0.36	ND	5.06 "
C-8	clean up " "	"	298 "	0.20	0.18	0.63	0.58	0.48	0.08	5.03 "
C-9	woodtex tender	"	sample lost in analysis							
C-10	leadman coater line	"	306 min	0.35	0.10	0.47	0.49	0.27	ND	4.25 "
C-12	tab man-hallmark "	9/30	430 "	0.09	0.10	2.22	1.59	0.67	0.08	12.56 "
C-14	laborer-hallmark line	"	426 "	0.14	0.20	0.94	0.54	0.54	0.30	4.93 "
C-16	sat. op. coater line	"	417 "	0.06	0.12	0.21	0.21	0.14	ND	2.40 "
C-17	clean up " "	"	397 "	0.17	0.10	0.57	0.77	0.45	ND	5.04 "
C-18	press roll op." "	"	406 "	0.17	0.07	0.86	0.66	0.25	ND	4.93 "
C-20	leadman coater line	"	392 "	0.09	ND	1.06	0.81	0.32	0.11	6.39 "

*ND - not detected (less than 10 micrograms per charcoal tube)
1 - HE (heptane levels in mg/m^3)
2 - OC (octane levels in mg/m^3)
3 - NO (nonane levels in mg/m^3)
4 - DE (decane levels in mg/m^3)
5 - UN (undecane levels in mg/m^3)
6 - DO (dodecane levels in mg/m^3)
7 - HC (total aliphatic hydrocarbons includes an estimate of the unidentified peaks)