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 # 76-55-443

CERTAIN-TEED PRODUCTS, INC.
TACOMA, WASHINGTON

NOVEMBER 1977

TOXICITY DETERMINATION

It is determined that the employees' exposure to asphalt fume and total dust (includes all particulates) was toxic as used and found on October 12 and 13, 1976. This conclusion is based on 1) the sample results which showed that the coater man was exposed to asphalt fume concentrations in excess of the evaluation criteria, and the dry felt man, coater man, coater trainee, slate man, and press operator were exposed to total dust concentrations in excess of 10 mg/m^3 (the dry felt man's exposure was found to be reduced on a subsequent sampling period as a result of a process change); and 2) eye irritation experienced by three of the nine workers and mild to moderate redness of the conjunctiva during the course of the shift of seven of the nine saturator workers.

It is determined that the employees' exposure to benzo(*a*)pyrene, other polynuclear aromatics, α and β naphthylamine, respirable dust, free silica, benzene, and other aromatic and aliphatic hydrocarbons were not toxic as used or found on October 12 and 13, 1976, and March 16 and 24, 1977. This conclusion is based on the sample results which show that these materials were well below the most restrictive of the evaluation criteria selected.

There was slight nose, throat and skin irritation experienced by the employees exposed to fibrous glass and formaldehyde but more toxic effects were not found. The fibrous glass and formaldehyde air concentrations were less than the most restrictive evaluation criteria selected.

There was insufficient data collected to make a determination on the toxicity of the carbon monoxide present. Potential toxic levels up to 100 ppm were measured, but the time weighted average may not exceed 35 ppm.

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 NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

(1) Certain-Teed Products, Inc., Tacoma, Washington.
(2) United Paperworkers Local #237, Tacoma, Washington.
(3) United Paperworkers International Union, Flushing, New York.
(4) Washington Industrial Safety and Health Administration, Washington Department of Labor, Olympia, Washington.
(5) Occupational Safety and Health Administration, Region X, Seattle, Washington.

For the purpose of informing the approximately 20 "affected employees," the employer will promptly "post" the Determination Report in a prominent place(s), near where the affected employees work, for a period of thirty (30) calendar days.

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 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, New York, 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, fibrous glass, formaldehyde, asphalt (petroleum), colored granules, limestone, talc, and mica.

HEALTH HAZARD EVALUATION

A. Description of Process

Certain-Teed Products, Inc. processes felt and fibrous glass asphalt shingles and rolled roofing products. The request involves the production of these products. The rolled felt is fed in a continuous ribbon through accumulation loops, makes two 90 degree turns, and enters the saturator (before the evaluation was completed, the 90 degree turns were removed and the feed roll was put directly in line with the saturator). In

the saturator, hot petroleum asphalt of approximatelv 400°F is sprayed and flowed onto the felt. As the felt exits the saturator, it is completely saturated with the asphalt. The saturator is enclosed and is kept under negative pressure with the use of local exhaust ventilation. The saturated felt then passes into the coater. From this point on, the felt and the fibrous glass are treated the same (the fibrous glass passes through the accumulator loops and saturator, however, no asphalt is applied to the fibrous glass in the saturator). In the coater, hot asphalt that has been thickened with limestone is flowed on the top side of the felt or fiberglass. The coater is enclosed and is provided with local exhaust ventilation. The asphalt is then spread with rollers and passes to the press area where the slate granules are dropped on the surface and pressed into the asphalt. There is no local exhaust ventilation over the press area. Dust can be seen being emitted from this process. After the granules have been pressed into the asphalt, a mixture of talc and sand is applied to the back side of the material to prevent sticking. The material passes through a water spray for cooling and another set of cooling and accumulation loops. From there, it passes through an operation called "Seal Down" where a thin stream of asphalt is applied to the shingles. It then proceeds to the cutter, where the individual shingles are cut from the continuous ribbon. The shingles are automaticallv stacked, wrapped, and proceed to the warehouse where they are placed on pallets and stored.

There are nine to eleven employees working in this area per shift, for the first and second shifts. The exposure that these employees have to the various chemicals is very diversified. Each operation has a man assigned to it and his exposure will be mainlv to the materials that are added at that point. In addition, the felt ribbon mav 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 may result in an exposure to higher concentrations of asphalt fume inside the saturator.

In addition to the operations described, there are two employees that are involved in handling the slate granules. Also, talc and sand are hand dumped from bags into a ventilated hopper.

In addition to the standard shingle manufacture, there is a "Hallmark" operation, where small strips of cut shingle are glued to the top of the standard shingle with hot asphalt. Visible fumes arise from the point where the asphalt is dripped on the shingle. This operation does contain local exhaust ventilation. The eight employees in this operation rotate through the jobs on a regular basis throughout the day, so the exposure to the asphalt is not continuous.

B. Study Progress and Design

1. General

The initial survey was conducted on July 2, 1976. The environmental/medical study was conducted on October 12 and 13, 1976. At that time, fibrous glass was not run, and was not to be run for some time. The environmental sampling for the fibrous glass run was conducted on March 16, 1977, and additional sampling for total dust, at the request of the company, was conducted on March 24, 1977. Between the environmental/medical survey in October and the March 24 date, the process flow was changed. The two 90 degree turns in the flow of the felt and fibrous glass ribbon between the roll feed and the saturator were removed. The company felt that this change would reduce the employee exposure dust levels and hence requested additional dust samples to be collected.

There are several other roofing companies in this overall study. The investigators felt that it was desirable to have the results of at least one other plant before continuing on with the other plants. This would allow the investigators to make any changes in the environmental sampling that would be needed.

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 (cyclohexane solubles, benzo(a)pyrene, and other polynuclear aromatics)		23
--Benzene and other aromatic and aliphatic hydrocarbons		19
-- α and β naphthylamine, benzo(a)pyrene, and other PNA's on silica gel tubes		4
--Carbon Monoxide		7
--Fibrous Glass	Total Weight	11
	Fiber Count	9
--Formaldehyde		13
--Respirable dust		3
--Silica (free SiO_2)		4
--Total Particulates		35

3. Medical

The medical evaluation consisted of interviewing and examining fifteen workers by an occupational health nurse. A questionnaire containing identification data, smoking history, occupational health, and a medical history of complaints related to work was completed. A physical examination was performed, both before the shift on October 12 and at the end of the shift. Felt was used that day. During a breakdown in the process, temperature, pulse rate, respiration rate, and blood pressure were obtained on two workers before and after they entered the saturator. A short questionnaire was asked of the affected employees before and after the shift on the day that fiberglass was run. It involved the employee's description of his feeling of dry, sore, or irritated throat, dry or irritated nose, eye irritation, and whether or not his skin was itching at the present time, and under what conditions, whether working with fibrous glass or felt, that his skin was subject to itching.

C. Evaluation Methods - Environmental

The employee's 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 a fiberglass 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 then in turn analyzed for benzo(a)pyrene and other polynuclear aromatic compounds, using a liquid chromatograph equipped with a UV detector.

2. Asphalt Volatiles - The sampling method consisted of collection of the volatiles on charcoal tubes and silica gel tubes which were preceded by the fiberglass-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. The α and β naphthylamine, benzo(a)-pyrene, and other polynuclear aromatics present on the silica gel tubes were analyzed using a liquid chromatograph equipped with a UV detector.

3. Carbon Monoxide - The sampling method consisted of spot samples collected with length-of-stain detector tubes.

4. 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 fiberglass filters backed up by silver membrane filters. The filters were all re-weighed upon receipt in the laboratory.

5. Fibrous Glass - Two sampling methods were used depending on the analytical work to be done.

a. Counting Method - The samples were collected on 0.8 u membrane filters in open face cassettes at a flow rate of 1.7 liters per minute. The fiber count per square millimeter of filter was done using phase contract microscopy.

b. Total Weight - The samples were collected on tared vinyl metricel filters at a flow rate of 1.7 liters per minute. The samples were re-weighed upon receipt at the laboratory.

6. Formaldehyde - The sampling method consisted of collection of the vapor in midget impingers using 1% sodium bisulfite as the absorbing reagent at a flow rate of 1.0 liters per minute. The samples were analyzed using colorimetric techniques. Length-of-stain detector tubes were also used.

7. 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 1976 (1); and NIOSH Criteria Documents for Recommended Occupational Exposure to Benzene (Revised Recommendation) (2), Occupational Exposure to Carbon Monoxide (3), Occupational Exposure to Fibrous Glass (4), Occupational Exposure to Formaldehyde (5), and Occupational Exposure to Crystalline Silica (6).

SUBSTANCE	U.S. DEPT OF LABOR STANDARDS	ACGIH TLV's* TWA**	NIOSH RECOMMENDED LEVELS
Asphalt (Petroleum) Fume	--	5 mg/m^3***	--
Benzene - Skin	1 ppm**** 5 ppm for any 15 min. period	25 ppm C*****	1 ppm (3.2 mg/m^3) for any two hour period
Carbon Monoxide	50 ppm	50 ppm	35 ppm
Dust (Nuisance) includes mica, non-asbestos form talc, limestone, felt dust, etc.			
Total Dust	15 mg/m^3	10 mg/m^3	--
Respirable Fraction	5 mg/m^3	5 mg/m^3	--
Fibrous Glass	--	--	3 fibers/cc with a dia $\leq$ 3.5 u and a length $\geq$ 10 u or 5 mg/m^3
Formaldehyde	3 ppm	2 ppm	1 ppm for any 30 min. sampling period
Silica (Crystalline)			
"Total Dust", respirable and non-respirable	$\frac{30\ mg/m^3}{\%\ SiO_2 + 2}$	$\frac{30\ mg/m^3}{\%\ SiO_2}$	
Respirable Fraction	$\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$	$\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$	0.050 mg/m^3 of SiO_2 in respirable fraction

* TLV - Threshold Limit Value

** TWA - Time Weighted Average

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

**** ppm - Parts of vapor or gas per million parts of air

***** C - CEILING VALUE, a value not to be exceeded at any time

NOTE: There are no recommended levels for benz(a)pyrene and other polynuclear aromatic compounds, and aliphatic hydrocarbons C-8 to C-16

2. Toxic Substances Medical Data

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

Asphalt (Petroleum) Fume (8,9) - 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-8 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 PNA's may consist of anthracene, chrysene, phenanthrene, pyrene, and benzo(@)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.

Benzene (7) - "Benzene has been recognized as a toxic substance capable of causing acute or chronic effects. Inhalation is the primary route of entry of benzene in the worker. Benzene diffuses rapidly through the lungs and is quickly absorbed into the blood. The rate of absorption is greatest during the first five minutes and thereafter declines significantly. Benzene saturation of the circulating blood may reach as high as 70-80 percent of the air content of benzene within the first 30 minutes. Relatively complete saturation of the blood may not be attained for two to three days. Benzene exerts a primary toxic effect in the bone marrow, the major blood forming organ. Longterm exposures to low concentrations of benzene have been observed to have an initial stimulatory effect on the blood-forming tissues (bone marrow) followed by aplasia (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 are continued, to aplastic anemia (lack of functioning of bone marrow), leucopenia (decrease in leucocytes which are white blood cells), thrombocytopenia (decrease in platelets), or pancytopenia (decrease in all cells in the peripheral blood). Secondary effects of thrombocytopenia include coagulation disturbances, characterized by increased bleeding time, poor clot retraction, and increased susceptibility to hemorrhaging. This clinical picture of chronic benzene poisoning may exist with or without the physical signs or symptoms of fatigue, vertigo, headache, or excessive bleeding." Several studies have suggested an association between benzene exposure and leukemia.

Fibrous Glass (4) - "The recommended standard has been designed to protect workers against the development of acute and chronic effects of exposure to fibrous glass. The acute effects include skin, eye, and respiratory tract irritation. The standard is also based on preventing chronic effects such as bronchiolar impairment, fibrosis, and carcinogenesis. The term fibrous glass describes a set of materials that can have different dimensions and consequently different biologic effects. Even though observed adverse effects of fibrous glass on humans have been confined primarily to skin irritation due to mechnical action, concern over possible longterm injury arising from inhaled fibers was evident from the earliest use of fibrous glass. Despite limited evidence of chronic effects from inhalation of fibrous glass, this concern continues to prevail, particularly with respect to possible longterm adverse effects in humans from exposure to fibers less than 3.5 um in diameter over long periods of time. However, an evaluation of the available information has resulted in the NIOSH conclusion that occupational exposure to fibrous glass has not resulted in the development of cancer. No cases of human cancer that can be directly linked to exposure to fibrous glass exposure have been found. Many gaps are present in the literature on effects of fibrous glass on humans and animals. Few relevant animal experiments have been performed."

Formaldehyde (5) - 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 and eye irritation have been shown to become less sensitive with time as one adapts to formaldehyde. Some persons, if not acclimatized, will experience unpleasant eye, nose, and throat irritation at concentrations below 5 ppm.

Nuisance Dusts (8) - 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 (7) - 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. Results and 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

Asphalt Fumes - Nineteen samples were collected for asphalt fumes. The results are shown in Table 2. These samples contained asphalt fumes, plus any other dust the employee was exposed to. When the pitch is dissolved in cyclohexane, all of it is soluble. However, on bulk air samples collected in the saturator, less than 20 percent of the material collected was soluble. Since only 20 percent of the bulk air sample was soluble, it can be assumed that the total asphalt fume collected is greater than the cyclohexane solubles on the filter. Assuming that only the cyclohexane soluble material was asphalt fumes, then one of the nineteen exceeded the evaluation criteria of 5 mg/m^3, and seventeen were less than half the criteria. The one high sample was on the coater man, who may spend considerable time in the coater on any one day. If we consider the jobs that could spend considerable time in the saturator and coater (saturator operator, coater man, and coater trainee) and assume that most of the material on the filter was asphalt fume, then six out of six samples exceeded the evaluation criteria for asphalt fume.

Benzo(a)pyrene (BAP) and other Polynuclear Aromatics (PNA's) and α and β Naphthylamines - Nineteen filter samples and four silica gel tube samples were analyzed for these substances. The results are shown in Tables 2 and 6. All the samples contained less than the minimum detectable amounts and it is concluded they were either not present, or if they are present, they are in very low concentrations.

Total and Respirable Dust (includes all particulates) - Thirty-five samples were collected for total dust and three for respirable dust. These results are shown in Table 1. Seven of the 35 samples exceeded the total dust criteria of 10 mg/m^3. The high samples had a range of 11.11 mg/m^3 to 31.90 mg/m^3. These 7 samples were collected on the following jobs: dry felt man, coater man, coater trainee, slate man, and press operator. After the feed roll was put in line with the saturator, the dry felt man's exposure to dust was reduced from an average of 12.5 mg/m^3 to 1.7 mg/m^3 and the saturator operator from 7.27 mg/m^3 to 2.2 mg/m^3. The 3 respirable dust samples were less than the evaluation criteria of 5 mg/m^3. These 3 samples, plus one total dust sample, contained less than detectable amounts of free SiO_2.

Aromatic and Aliphatic Hydrocarbons - Nineteen charcoal tube samples were collected for volatile hydrocarbons. The results are shown in Table 3. The identified aliphatic hydrocarbons were C-8 to C-16 hydrocarbons. These results are shown in Table 4. The total combined concentrations of these hydrocarbons was less than 1.5 mg/m^3, which is less than 1 ppm. There were a number of identified aromatic hydrocarbons present, one of which was benzene. The results are shown in Table 5. The benzene concentrations were all 0.22 mg/m^3 or less, which is less than 7% of the new benzene criteria of 3.2 mg/m^3 (1 ppm). The total identified aromatics were all less than 1.8 mg/m^3, which is less than 1 ppm. The estimated total aromatic and aliphatic hydrocarbons were less than 7.1 mg/m^3, which is less than 3 ppm. Although the total volatile hydrocarbons were low, the concentration in the hallmark operation was twice that in the saturator area.

Fibrous Glass - The fibrous glass sampling was done by both the fiber counting method and the weight method, as the evaluation criteria considers both methods. The results are shown in Table 7. All the fibrous glass counts were less that 0.1 fibers/cc (fibers less than or equal to 3.5 u diameter and greater than or equal to 10 u length), which is less than 4% of the evaluation criteria of 3 fibers/cc. Although the counts were low, visible fibrous glass particles could be seen in the air, hence it was also desirable to have the exposure determined on a weight basis. The concentrations ranged from 0.40 to 3.24 mg/m^3, with a mean of 1.05 and a median of 0.81 mg/m^3. These results were all less than the evaluation criteria of 5 mg/m^3.

Formaldehyde - The fibrous glass mat is bound together with a urea-formaldehyde resin. When the fibrous glass rolls are spliced together with a hot iron, and when the hot asphalt is flowed on the fibrous glass, formaldehyde is released. The results are shown in Table 8. The time weighted average formaldehyde concentration at the splicing operation was 0.11 ppm, at the accumulator loops it was 0.09 ppm, and just outside the coater it was 0.01 ppm. These were all less than the evaluation criteria of 1 ppm. Detector tube samples were collected during the splicing operation and in the coater enclosure. The splicing takes about 15 seconds and occurs once every 6 to 10 minutes. During the splice the formaldehyde concentrations were from 2.5 to 5 ppm. In the coater enclosure the concentration was 3 to 4 ppm. Depending on the day and the circumstances, the coater man could spend considerable time in the enclosure and in any 30 minute period could exceed the evaluation criteria of 1 ppm for any 30 minute period.

Carbon Monoxide - Carbon monoxide samples were collected in the Hallmark area. The results are shown in Table 9. The concentration ranged from 10 to 100 ppm. The forklift is in the area only a portion of the day, hence the time weighted average concentrations would be expected to be lower. The time weighted average carbon monoxide concentrations, however, could exceed the evaluation criteria of 35 ppm.

Asbestos - The talc was analyzed for asbestos, however, it was not present.

2. Medical

All the examined employees were males whose ages ranged from 24 to 53 with a mean of 32.4. Six men were employed on the Hallmark line and nine men were employed on the saturator line. The time employed at the plant ranged from 1 to 25 years, with a mean of 7 years. Four men had been employed for one year, five for 2 to 5 years, three for 6 to 10 years, and three for 15 to 25 years.

a. Hallmark Workers

Three of the six examined Hallmark workers complained of eye irritation which they attributed to work. On post-shift examination, one of these workers did have mild to moderate redness of the conjunctiva which was not present on pre-shift examination.

Three of the six examined workers complained of dry or sore throat which they attributed to work. Two of these workers did develop mild to moderate redness of the throat during the course of the shift. One worker complained of nasal irritation and another complained of occasional dry cough and nausea which he attributed to the odor of the glue.

None of the Hallmark workers complained of skin irritation and no dermatitis was observed. All of the interviewed Hallmark workers denied past or current breathing problems.

b. Saturator Workers

Three of the nine examined saturator workers complained of eye irritation which they attributed to work. Seven of the 9 workers developed mild to moderate redness of the conjunctiva during the course of the shift. Six workers complained of nasal irritation and four complained of dry or sore throat which they attributed to work. On post-shift examination, four workers did have mild to moderate redness of the throat which was not present on pre-shift examination. One worker stated that he gets a fine red rash on his arms and legs when working with fiberglass. He stated that the rash goes away when he goes home and showers. One worker complained of shortness of breath, but he could not attribute this only to work because he is a smoker. All other interviewed workers denied past or current breathing problems.

On occasions when there is a break-down in the process, it is necessary for one or two workers to be exposed to temperatures greater than or equal to 150° F. Such a break-down occurred on the day of the NIOSH visit. In order to determine the possibility of heat stress, temperature (oral), pulse, respiration, and blood pressure were taken on two workers before and after exposure to the high temperatures.

	Temp.	Pulse	Respiration	Blood Pressure
Worker #1				
Before entering Saturator	97.6	82	24	120/60
After exiting Saturator	98.4	116	20	140/60
(Time in Saturator - 13 minutes)				
Worker #2				
Before entering Saturator	97	64	20	140/70
After exiting Saturator	98.8	88	24	130/60
(Time in Saturator - 28 minutes)				

In both cases there are slight increases in vital signs. However, it is not possible to attribute this increase only to high temperatures since the workers were very physically active at the time.

Three workers who handled the fiberglass were questioned before the shift started and after the shift ended on the day that fiberglass was run. None of the three workers had any itching of the skin before work. At the end of the shift, all three had itching with the main location of the itching being on the face. All three stated that their skin did not itch when felt was being processed, but it did itch when fiberglass was being run.

Formaldehyde is an eye, nose, and throat irritant. None of the three employees had any eye, nose, or throat irritation prior to the work shift. At the end of the work shift, two of the three had slightly irritated eyes, all three had irritated noses, and two of the three had sore, irritated throats.

F. Conclusions

It is determined that the employee's exposures to asphalt fume and total dust (includes all particulates) was toxic as used and found on October 12 and 13, 1976. This conclusion is based on 1) the sample results which showed that the coater man was exposed to asphalt fume concentrations in excess of the evaluation criteria, and the dry felt man, coater man, coater trainee, slate man, and press operator were exposed to total dust concentrations in excess of 10 mg/m^3. (The dry felt man's exposure was found to be reduced on a subsequent sampling period as a result of a process change); and 2) eye irritation experienced by three of the nine workers and mild to moderate redness of the conjunctiva during the course of the shift of seven of the nine saturator workers.

It is determined that the employees' exposure to benzo(α)pyrene, other polynuclear aromatics, α and β naphthylamine, respirable dust, free silica, benzene, and other aromatic and aliphatic hydrocarbons were not toxic as used or found on October 12 and 13, 1976, and March 16 and 24, 1977. This conclusion is based on the sample results which show that these materials were well below the most restrictive of the evaluation criteria selected.

There was slight nose, throat, and skin irritation experienced by the employees exposed to fibrous glass and formaldehyde but more toxic effects were not found. The fibrous glass and formaldehyde air concentrations were less than the most restrictive evaluation criteria selected.

There was insufficient data collected to make a determination on the toxicity of the carbon monoxide present. Potential toxic levels up to 100 ppm were measured, but the time weighted average may not exceed 35 ppm.

G. Recommendations

1. Provide local exhaust ventilation on the slate transfer points in the slate man's tower.

2. Although the total dust and the respirable dust levels are just below the evaluation criteria, it would be advantageous for the relief man to wear respiratory protection when dumping the talc as this operation probably contributes significantly to his overall exposure. The size of the opening where the talc is dumped could be reduced thereby increasing the capture of the materials.

3. The leaks in the limestone transfer system should be repaired.

4. It is preferable to vacuum instead of sweeping fine dust. This prevents the dust from becoming airborne.

5. Compressed air should not be used to blow fine dust out of equipment; vacuuming is preferred. If the material cannot be removed any other way, then an approved respirator for use with dust should be worn by the individual during this operation.

6. The ceiling fan over the coater was off during this evaluation. The fumes tend to build up near the ceiling and these fans should be left on during the time the saturator and coater are being used.

7. The saturator and coater tend to leak around the doors. This can be prevented by either increasing the exhaust ventilation rate or by installing better seals on the doors.

8. During the course of a day the saturator operator and coater man may spend considerable time in the saturator and coater. Respiratory protection should be worn during the time spent inside this equipment. It could be either a supplied-air respirator or a respirator consisting of a dust, fume, and mist cartridge in combination with an organic vapor cartridge. It would be preferable to use a full-face or a hooded type of respirator as the eyes are subject to irritation by the asphalt fumes.

9. The ventilation system on the Hallmark operation could be revised slightly to increase the amount of local exhaust ventilation applied to the asphalt vat. The fine screen was removed during this evaluation and

increased the exhaust ventilation rate dramatically. The elbows used are corrugated and are not smooth, thus restricting the flow by an increase of resistance. In addition, there is considerable amount of flexible duct. Flexible duct increases the resistance to air flow and the use of flexible duct should be kept to a very minimum. In the same area, there is a fan installed that blows air across the top of the operation, where the asphalt is dripped on the shingles. This air movement disturbs the capture zone of the local exhaust system and should be removed or shut off.

10. A gasoline powered forklift is currently used in the Hallmark area. A gasoline engine produces considerable quantities of carbon monoxide. The carbon monoxide concentrations measured indicated that carbon monoxide is a potential problem in this area. An electric forklift is preferred. If an electric forklift is not used, then the engine should be converted to propane, which although producing carbon monoxide, usually will produce a lower quantity. In addition, the engine must be kept well tuned.

11. The continued use of disposable coveralls is advised when running fiberglass. In addition to wearing the coveralls, they should tape the sleeves, legs, and neck openings tight against the skin. It is also desirable to change and wash the clothing worn under the coveralls at the end of each shift and shower before going home.

12. Employees who may be exposed to fibrous glass, asphalt fume 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 examination giving particular attention to the skin and respiratory system. Examinations should include simple tests for dermographism, and such tests of pulmonary function as FEV 1 and FVC 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, dust and asphalt fume, shall be counseled on the increased risk of impairment of their health from working with this substance.

REFERENCES

1. Threshold Limit Values (TLV) for Chemical Substances and Physical Agents in the Workroom Environment for 1976, by the American Conference of Governmental Industrial Hygienists.

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 Carbon Monoxide," Department of Health, Education, and Welfare Publication No. HSM-73-11000, 1972.

4. NIOSH "Criteria for a Recommended Standard . . . Occupational Exposure to Fibrous Glass," Department of Health, Education, and Welfare Publication No. (NIOSH) 77-152, 1977.

5. NIOSH "Criteria for a Recommended Standard . . . Occupational Exposure to Formaldehyde," Department of Health, Education, and Welfare Publication No. (NIOSH) 77-126, 1976.

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

7. Occupational Exposure to Benzene, Emergency Temporary Standard Hearing, Federal Register Vol. 42, #85, Tuesday, May 3, 1977.

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

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

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T A B L E 1

TOTAL AND RESPIRABLE PARTICULATES AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

TYPE OF SAMPLE	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	mg/m^3 *
BZ +T. Particulates	Dry Felt Man	10-12-76	V-725	440	748	14.4
BZ T. Particulates	Dry Felt Man	10-13-76	V-859	385	655	9.7
GA ++T. Particulates	Dry Felt Area	10-12-76	V-2300	405	689	6.1
GA T. Particulates	Dry Felt Area	10-13-76	V-2256	410	697	7.6
BZ T. Particulates	Slate Man	10-13-76	V-3092	225	383	16.1
BZ T. Particulates	Slate Man	10-13-76	V-2249	181	308	6.5
BZ R. Particulates	Slate Man	10-12-76	PV-447	410	697	2.3***
BZ T. Particulates	Relief Man	10-13-76	V-3083	230	391	7.6**
BZ T. Particulates	Relief Man	10-13-76	V-2264	206	350	8.3
BZ R. Particulates	Relief Man	10-12-76	PV-359	402	683	4.1***
GA T. Particulates	Below Line where excess slate is collected	10-13-76	PV-390	70	119	2.1***
GA R. Particulates		10-13-76	PV-377	70	119	0.03***
BZ T. Particulates	Dry Felt Man	3-24-77	1	410	697	1.7

T A B L E 1 (C O N T .)

TOTAL AND RESPIRABLE PARTICULATES
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

	TYPE OF SAMPLE	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	mg/m^3*
BZ	T. Particulates	Seal Down Operator	10-12-76	S-7	415	415	0.99
BZ	T. Particulates	Seal Down Operator	10-13-76	S-43	392	392	1.43
BZ	T. Particulates	Foreman	10-12-76	S-14	419	419	5.25
BZ	T. Particulates	Foreman	10-13-76	S-53	422	422	6.33
GA	T. Particulates	Extreme south end where dry felt will be	10-13-76	S-38	422	422	2.01
BZ	T. Particulates	Hallmark Operation (Everyone here rotates jobs about every 30 minutes)	10-12-76	S-15	410	410	1.60
BZ	T. Particulates		10-12-76	S-17	385	385	2.16
BZ	T. Particulates		10-12-76	S-20	406	406	1.43
BZ	T. Particulates	"	10-12-76	S-24	405	405	1.53
BZ	T. Particulates	"	10-13-76	S-35	422	422	1.82
BZ	T. Particulates	"	10-13-76	S-36	420	420	1.67
BZ	T. Particulates	"	10-13-76	S-37	425	425	0.96

T A B L E 1 (C O N T .)

TOTAL AND RESPIRABLE PARTICULATES
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

	TYPE OF SAMPLE	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	mg/m^3*
BZ	T. Particulates	Saturator Operator	3-24-77	2	410	697	2.2
GA	T. Particulates	By dry felt rolls on platform	3-24-77	3	440	748	0.3
GA	T. Particulates	By Accumulator loops 6½ ft. above floor	3-24-77	4	440	748	1.0
BZ	T. Particulates	Saturator Operator	10-12-76	S-1	431	431	7.19
BZ	T. Particulates	Saturator Operator	10-13-76	S-46	394	394	7.34
BZ	T. Particulates	Coater Man	10-12-76	S-2	430	430	13.77
BZ	T. Particulates	Coater Man	10-13-76	S-40	398	398	14.57
BZ	T. Particulates	Coater Trainee	10-12-76	S-33	290	290	14.67
BZ	T. Particulates	Coater Trainee	10-13-76	S-44	395	395	11.11
GA	T. Particulates	By coater	10-12-76	S-3	425	425	2.71
BZ	T. Particulates	Press Operator	10-12-76	S-5	415	415	31.90
BZ	T. Particulates	Press Operator	10-13-76	S-45	395	395	6.08

T A B L E 1 (C O N T .)

TOTAL AND RESPIRABLE PARTICULATES
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

	TYPE OF SAMPLE	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	mg/m^3*
GA	T. Particulates	Over Dripper	10-12-76	S-28	435	435	0.64
GA	T. Particulates	Over Dripper	10-13-76	S-39	455	455	0.06

\+ BZ- Breathing Zone

++ GA- General Area

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

** Pump shut off accidently. Time lost is unknown, therefore sample VOID.

*** Free Silica determination was run on these samples. All contained less than the detectable amount of 0.02 mg/sample.

T A B L E 2

ASPHALT FUME (CYCLOHEXANE SOLUBLE),
BENZO(A)PYRENE (BaP) & POLYNUCLEAR AROMATICS (PNA)
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

JOB OR LOCATION	DATE	FILTER SAMPLE NUMBER	CORRESPONDING CHARCOAL OR SILICA GEL TUBE SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	TOTAL WT. mg/m^3*	CYCLOHEXANE SOLUBLE mg/m^3	BAP ug/SAMPLE	OTHER PNA's TESTED ug/SAMPLE
BZ+ Saturator Operator	10-12-76	S-1	C-51	431	431	7.19	0.81	<0.05	<2
"	10-13-76	S-46	SG-74	394	394	7.34	2.55		
BZ Coater Man	10-12-76	S-2	C-52	430	430	13.77	0.87		
"	10-13-76	S-40	C-75	398	398	14.57	6.84		
BZ Coater Trainee	10-12-76	S-33	C-57	290	290	14.67	2.33		
"	10-13-76	S-44	C-70	395	395	11.11	0.30		
GA‡ By Coater	10-12-76	S-8	SG-55	425	425	2.71	1.00		
BZ Press Operator	10-12-76	S-5	C-53	415	415	31.90	1.47		
"	10-13-76	S-45	C-73	395	395	6.08	1.37		
BZ Seal Down Operator	10-12-76	S-7	C-54	415	415	0.99	0.43		
"	10-13-76	S-43	C-69	392	392	1.43	1.18		
BZ Foreman	10-12-76	S-14	C-56	419	419	5.25	0.53		
"	10-13-76	S-53	C-72	422	422	6.33	0.47		

TABLE 2 (CONT.)

ASPHALT FUME (CYCLOHEXANE SOLUBLE),
BENZO(A)PYRENE (BAP) & POLYNUCLEAR AROMATICS (PNA)
AIR CONCENTRATIONS

	JOB OR LOCATION	DATE	FILTER SAMPLE NUMBER	CORRESPONDING CHARCOAL OR SILICA GEL TUBE SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	TOTAL WT. mg/m^3*	CYCLOHEXANE SOLUBLE mg/m^3	BAP ug/SAMPLE	OTHER PNA's TESTED ug/SAMPLE
GA	Extreme South End Where Dry Felt Will Be	10-13-76	S-38	C-71	422	422	2.01	--	<0.05	<2
BZ	Hallmark Operation (Everyone here rotates jobs about every 30 minutes)	10-12-76	S-15	C-61	410	410	1.60	--		
		10-12-76	S-17	C-60	385	385	2.16	0.76		
		10-12-76	S-20	C-63	406	406	1.43	--		
		10-12-76	S-24	SG-62	405	405	1.53	0.61		
	"	10-13-76	S-35	C-65	422	422	1.82	0.38		
	"	10-13-76	S-36	C-66	420	420	1.67	0.53		
	"	10-13-76	S-37	SG-67	425	425	0.96	0.23		
GA	Over Dripper	10-12-76.	S-28	C-64	435	435	0.64	0.23		
	" "	10-13-76	S-39	C-68	455	455	0.86	0.10		

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

T A B L E 3

AROMATIC HYDROCARBONS & ALIPHATIC HYDROCARBONS
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	TOTAL IDENTIFIED AROMATICS[1] mg/m^3*	TOTAL IDENTIFIED ALIPHATICS[2] mg/m^3	ESTIMATED LOW M.W. ALIPHATICS mg/m^3	ESTIMATED UNIDENTIFIED AROMATICS & ALIPHATICS mg/m^3	EST. TOTAL AROMATICS & ALIPHATICS mg/m^3
BZ +	Saturator Operator	10-12-76	C-51	431	431	0.68	0.36	0.65	0.26	1.86
BZ	Coater Man	10-12-76	C-52	430	430	0.53	0.48	0.95	0.49	2.32
"	" "	10-13-76	C-75	398	398	0.51	0.59	0.90	0.63	2.51
BZ	Coater Trainee	10-12-76	C-57	290	290	0.46	0.39	0.97	0.32	2.07
"	" "	10-13-76	C-70	395	395	0.59	0.55	0.56	0.73	2.53
BZ	Press Operator	10-12-76	C-53	415	415	0.64	0.30	1.04	0.46	2.41
"	" "	10-13-76	C-73	395	395	0.51	0.34	0.78	0.43	2.03
BZ	Seal Down Operator	10-12-76	C-54	415	415	0.63	0.32	1.11	0.43	2.41
"	" " "	10-13-76	C-69	392	392	0.58	0.41	0.77	0.46	2.30
BZ	Foreman	10-12-76	C-56	419	419	0.38	0.22	0.88	0.24	1.67
"	"	10-13-76	C-72	422	422	0.32	0.21	0.49	0.33	1.42
GA ‡	South End Where Dry Felt Will Be	10-13-76	C-71	422	422	0.38	0.36	0.31	0.33	1.42

TABLE 3 (CONT.)

AROMATIC HYDROCARBONS & ALIPHATIC HYDROCARBONS
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	TOTAL IDENTIFIED AROMATICS 1/ mg/m^3*	TOTAL IDENTIFIED ALIPHATICS 2/ mg/m^3	ESTIMATED LOW M.W. ALIPHATICS mg/m^3	ESTIMATED UNIDENTIFIED AROMATICS & ALIPHATICS mg/m^3	EST. TOTAL AROMATICS & ALIPHATICS mg/m^3
BZ	Hallmark Operators	10-12-76	C-61	410	410	1.08	0.89	1.51	1.22	4.63
"	" "	10-12-76	C-60	385	385	1.18	0.79	2.08	1.17	5.19
"	" "	10-12-76	C-63	406	406	1.58	1.08	1.90	1.58	6.16
"	" "	10-13-76	C-65	422	422	1.23	1.08	1.18	1.66	5.21
"	" "	10-13-76	C-66	422	422	1.08	0.93	1.26	1.29	4.52
GA	Over Dripper in Hallmark	10-12-76	C-64	435	435	1.73	1.26	2.11	2.00	7.13
"	" "	10-13-76	C-68	455	455	1.49	1.44	1.34	2.20	6.37

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

1/ Identified Aromatics were Benzene, Toluene, Ethylbenzene, M-, P-, and O-Xylene, 1,3,5 Trimethylbenzene, and 1,2,4 Trimethylbenzene.(See Table 5)

2/ Identified Aliphatics were N-Octane (C-8) to n-Hexadecane (C-16). (See Table 4)

+ BZ - Breathing Zone

‡ GA - General Area

T A B L E 4

AIR CONCENTRATIONS OF INDIVIDUAL
IDENTIFIED ALKANES FROM TABLE 3

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

SAMPLE NUMBER	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 Alkanes ug/m^3
C-51	58	60	44	44	51	46	28	28	5	364
C-52	65	84	60	60	67	51	37	44	14	483
C-75	65	78	70	70	80	65	60	68	32	590
C-57	59	66	52	55	55	38	24	31	10	390
C-70	58	73	94	99	91	53	33	38	15	554
C-53	55	63	43	41	51	43	27	29	10	361
C-73	41	51	48	61	56	41	25	25	8	354
C-54	53	53	39	39	46	41	24	24	5	323
C-69	64	54	46	56	82	46	28	26	5	406
C-56	35	35	26	24	31	24	17	21	7	222
C-72	36	12	28	26	36	31	17	19	7	211
C-71	31	38	66	66	76	33	24	21	7	363
C-61	129	110	95	98	120	127	100	90	20	885
C-60	13	135	96	81	114	135	99	99	21	792
C-63	108	150	133	131	150	148	121	106	20	1076
C-65	78	123	118	133	164	178	118	137	33	1083
C-66	83	107	97	104	140	145	118	104	26	924
C-64	120	170	152	156	184	198	120	133	32	1264
C-68	84	130	145	187	235	244	202	178	37	1442

ug/m^3 - micrograms of substance per cubic meter of air

TABLE 5

AIR CONCENTRATIONS OF INDIVIDUAL IDENTIFIED
AROMATIC HYDROCARBONS FROM TABLE 3

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

SAMPLE NUMBER	Benzene ug/m^3	Toluene ug/m^3	Ethyl Benzene ug/m^3	M-Xylene & P-Xylene ug/m^3	O-Xylene ug/m^3	1,3,5 Trimethyl-benzene (Mestylene) ug/m^3	1,2,4 Trimethyl-benzene ug/m^3	Total Identified Aromatics ug/m^3
C-51	116	186	104	130	63	26	53	677
C-52	107	140	79	98	47	21	42	533
C-75	75	123	88	98	48	30	45	507
C-57	55	148	72	83	45	17	34	455
C-70	78	157	122	111	56	25	33	590
C-53	84	193	94	125	67	24	48	636
C-73	65	122	87	122	48	20	41	506
C-54	45	173	96	120	58	24	51	631
C-69	94	135	89	128	64	26	48	584
C-56	64	126	53	67	33	12	24	379
C-72	45	85	55	76	28	12	24	325
C-71	48	104	64	76	40	17	31	382
C-61	129	256	193	232	98	68	122	1098
C-60	125	275	213	257	109	62	138	1179
C-63	222	360	256	313	175	91	160	1576
C-65	121	265	223	258	123	90	145	1225
C-66	116	239	185	232	111	71	123	1078
C-64	175	395	301	356	202	110	189	1729
C-68	132	295	284	312	154	125	189	1490

ug/m^3 - micrograms of substance per cubic meter of air

T A B L E 6

α AND β NAPHTHYLAMINES, BENZO(A)PYRENE (BAP)
AND POLYNUCLEAR AROMATICS (PNA)
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

	JOB OR LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	α NAPHTHYLAMINE ug/SAMPLE	β NAPHTHYLAMINE ug/SAMPLE	BAP ug/SAMPLE	OTHER PNA's TESTED ug/SAMPLE
BZ	Saturator Operator	10-13-76	SG-74	394	394	< 1.0	< 1.0	< 0.05	< 2
GA	By Coater	10-12-76	SG-55	425	425	< 1.0	< 1.0	< 0.05	< 2
BZ	Hallmark Operator	10-12-76	SG-62	405	405	< 1.0	< 1.0	< 0.05	< 2
BZ	Hallmark Operator	10-13-76	SG-67	425	405	< 1.0	< 1.0	< 0.05	< 2

T A B L E 7

FIBERGLASS
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

JOB OR LOCATION	DATE	SAMPLE # (SIDE BY SIDE SAMPLES ARE NOTED)	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	FIBERS/cc*	mg/m^3**
BZ Dry Felt Man	3-16-77	V-2141	175	350	--	0.60
		and AA-1	175	350	<0.005	--
		V-2731	100	200	--	0.40
		and AA-7	100	200	<0.009	--
		V-1136	105	210	--	3.24
		and AA-12	105	210	<0.009	--
BZ Dry Felt - Saturator Man		V-2787	195	390	--	1.44
		and AA-2	195	390	<0.005	--
		V-2661	110	220	--	0.41
		and AA-8	110	220	<0.008	--
		V-1143	120	240	--	1.00
		and AA-10	120	240	<0.008	--

T A B L E 7 (C O N T .)

FIBERGLASS
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

JOB OR LOCATION	DATE	SAMPLE # (SIDE BY SIDE SAMPLES ARE NOTED)	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	FIBERS/cc*	mg/m^3**
GA ∓ by north end of accumulator loops on walk-way 7' above floor	3-16-77	V-2777 and AA-5	327 197	654 394	-- <0.005	0.81 --
		AA-9	130	260	<0.007	--
BZ Press Man		AA-4	190	380	<0.005	--
		V-2685 and AA-6	90 90	180 180	-- <0.01	0.72 --
		V-2786 and AA-11	125 125	250 250	-- <0.007	2.56 --

* Limit of Detection - 2 fibers/mm^2 - particles with a size/diameter ≤3.5 u and a length ≥10 u

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

\+ BZ - Breathing Zone

∓ GA - General Area

T A B L E 8

FORMALDEHYDE
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

LOCATION	DATE	SAMPLE NUMBER	SAMPLE TIME MIN.	SAMPLE VOL. LITERS	mg/m^3*	ppm**
GA # On platform where fiberglass rolls are spliced and unrolled	3-16-77	F-1	395	395	0.16	0.11
GA North end of accumulator loops 7 ft. above floor	3-16-77	F-2	395	395	0.14	0.09
GA Above the area where the slate is added just after the coater	3-16-77	F-3	390	395	0.02	0.01
6" above splice - total time of splice is approximately 15 seconds - change rolls every 6 - 10 minutes	3-16-77	4	spot sample	-	4.5	3
	3-16-77	5	"	-	4	2.5
In breathing zone during splice	3-16-77	6	"	-	7.5	5
In coater enclosure	3-16-77	7	"	-	6	4
" " "	3-16-77	8	"	-	4.5	3
In coater during repair of break 10 minutes into shutdown	3-16-77	9	"	-	-	<0.5
Inside of fiberglass roll	3-16-77	10	"	-	6	4

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

** ppm - Parts of vapor or gas per million parts of air

A - General Area

T A B L E 9

CARBON MONOXIDE
AIR CONCENTRATIONS

Certain-Teed Products, Inc.
Tacoma, Washington
HHE #76-55

LOCATION	DATE	TIME	ppm*
Hallmark Area			
between fork lift and Hallmark operation when gas fork lift was in the area	10-12-76	12:45 pm	100
" " "	10-12-76	12:55 pm	50
when gas fork lift was not in area	10-12-76	1:00 pm	50
by strip-cutter - fork lift in the area	10-12-76	1:30 pm	60
" " "	10-12-76	2:00 pm	50
by Hallmark operation - fork lift in the area	10-13-76	9:00 am	30
Saturator Area			
by saturator	10-13-76	10:00 am	10

* ppm - Parts of vapor or gas per million parts of air