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

HAZARD EVALUATION AND TECHNICAL ASSISTANCE
REPORT NO. HE 78-73-612

KENTILE FLOORS, INC.
CHICAGO, ILLINOIS
SEPTEMBER 1979

I. TOXICITY DETERMINATION

A survey team for the National Institute for Occupational Safety and Health (NIOSH) performed a health hazard evaluation at Kentile Floors Inc., Chicago, Illinois on June 26-27 and August 19-22, 1978, to evaluate alleged worker exposure to asbestos, polynuclear aromatic hydrocarbons (PNA), vinyl chloride monomer, talc, alpha methyl styrene, and numerous organic and inorganic dyes and pigments.

The methodology used to evaluate the workers' environment included: (1) environmental air sampling, (2) a review of materials inventory and the material safety data sheets, (3) a review of the Occupational Safety and Health Administration (OSHA) data collected during previous visits, (4) medical interviews and evaluations of workers, (5) a review of employees' health records, (6) a review of pertinent scientific literature, (7) a review of the company's respirator program, and (8) observations of employees' work practices and engineering controls.

Environmental air samples and bulk samples were collected and analyzed for the following contaminants (see Tables I-VI): carbon black, PNA's (benzo(a)pyrene, anthracene, phenanthrene, pyrene, chrysene, benzene-soluble fraction), mineral spirits, benzene, asbestos, total dust, lead, and total chromium. Asbestos was the only contaminant found to exceed a NIOSH recommended criteria. Eight of thirty asbestos samples exceeded the NIOSH recommended criteria of 0.10 fibers per cubic centimeter of air.

No cases of asbestosis were documented among the past and present workers at this plant. Of the three authenticated cases of cancer revealed in this investigation, only one should possibly be regarded as being of occupational origin. Since this cancer has a lengthy latent period, i.e., the amount of time elapsing between exposure to occupational carcinogen(s) and the development of a tumor, one cannot be sure in this case what the causative agent(s) could be, as prior to his first employment at this plant, the man worked in an industry associated with the development of respiratory-tract cancers.

II. DISTRIBTUION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (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 the following:

A. Kentile Floors, Inc., Chicago, Illinois
B. Authorized representatives of the United Rubber Workers (URW) Local No. 505, Chicago, Illinois
C. International Union of URW, Akron, Ohio
D. NIOSH - Region V
E. U.S. Department of Labor - Region V

For the purpose of informing the approximately 50 "affected employees", the employer shall promptly "post" for a period of 30 calendar days, the Determination Report in a prominent place(s) near where the exposed employees work.

II. 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 an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of employees. The request alleged that personnel were exposed to materials used in the production of vinyl asbestos and asphalt asbestos floor covering. Furthermore, "the OSHA industrial hygiene survey verified exposures to asbestos, benzo(a)pyrene, coal tar pitch volatiles and chrysene." Malignant tumors of various types were reported by the local union to the International Union and/or OSHA investigator. However, information associated with these reports seemed sketchy and warranted further investigation.

IV. HEALTH HAZARD EVALUATION

A. Process Description and Evaluation

Kentile Floors Inc. is a manufacturer of vinyl asbestos and asphalt asbestos floor covering. The company employs 300 workers

of whom approximately 250 are factory workers. The employees work one of two shifts (7:00 am - 4:30 pm or 4:30 pm - 2:00 am) nine hours per day, five days per week. The maintenance department works on Saturdays in order to perform routine equipment maintenance and repairs. The company performs environmental air sampling for asbestos, total dust, etc. However, the frequency of monitoring was not determined.

The areas evaluated were the process room, the recycling process and the ink mixing operation. All personnel assigned to the process room or recycling operation are assigned separate lockers for clean and dirty clothes. Additionally, workers are required to wear the following protective equipment: coveralls, respirator and safety shoes. Employees are relieved from duty ten minutes before the end of their shift in order to shower; however, showers are not mandatory.

Workers in the process room or the recycling area are each assigned two respirators. At the end of each shift, the dirty respirators are collected by the supervisor for daily cleaning. Two employees disassemble each respirator and hand-clean them according to requirements described in the respiratory guide supplied with the respirators. The units are air-dried, assembled with new filters, and returned to their respective owners at the beginning of their shift.

1. Process Room

In the process room, located in Building 2, chemical weighing and mixing is accomplished. There are two tile lines (#5 and #7) and a mottling or decorative tile line (#6) which are very similar operations. All three lines are operated by 20 workers during the day shift, whereas the second shift (10 workers) operates only one production line.

The materials are normally stored in the warehouse and transported to the process room, via fork lifts, as needed. Inadvertent chemical spills are normally vacuum cleaned.

Lines #5, #6 and #7 utilize a hopper car and a conveyor system for transporting chemicals from the scales to the *Banbury® mixer. The pigment operator measures the required quantities of pigments (from bulk materials) at a booth which has slot ventilation. The pigment is placed in a plastic bag and dropped into the hopper car. The hopper proceeds to the first of two scales, both of which have canopy exhaust ventilation, where the resin scale operator places a bag of asbestos onto a horizontal chute, splits it in both directions and pushes the bag into the hopper. Two additional chemicals are automatically

*Mention of commercial names or products does not constitute endorsement by NIOSH

metered and conveyed to the hopper. The hopper car is transferred to the second scale operator who loads the hopper with scrap tile. It should be noted that the scale operators switch positions every four hours. The hopper car is then conveyed to the Banbury mixer where the operator dumps the hopper load into one of two mixers inlet chute which are alternately charged and dumped onto a conveyor belt below.

In addition, the mixer operator triggers a switch which dumps the other chemicals (plasticizer, limestone, polyvinyl chloride pellets, scrap tiles, and water) into the inlet chute. The materials are mixed for the prescribed time; afterwhich, the load is released through the discharge chute. The mixture, when released, is hot (160-300^{o}F) due to frictional mixing. The mixture is subsequently conveyed to the mills to be gauged, colored, waxed, polished, cut and packed. The mottle, once gauged, is crushed and added to the vinyl asbestos tile.

Building 2 occupies about 4,500 square feet (ft^2) with an average ceiling height of about 25 feet. The entire ventilation system is purged through a bag house where the dust is collected, bagged and identified with a tag indicating asbestos dust. The exhaust system operates at 48,000 cubic feet per minute (cfm). The make-up air unit operates at 90,000 cfm. This make-up air is primarily used to cool the hot running machines.

The pigment scale operators' booth has slot ventilation (42 x 1 inch) which operates at about 50 feet per minute (fpm).

Each of the hopper scales have canopy exhausts which are enclosed on two sides and have curtains on two sides to increase exhaust efficiency. The system was designed to exhaust air away from the worker at a rate of 150 fpm when the hopper car is in place. Both Banbury machines for each of the three lines have two adjacent slot exhaust ducts at the chute entrance and one exhaust duct within the mixer. The exhaust duct at the chute entrance is designed to operate at 200-300 cfm per square foot of open face area.

2. Recycling Process

The recycling process, located on the second floor above the process room, is operated by two workers. one employee is the utility man/Banbury relief man and the other employee monitors the conveyor belts which transport scrap tile chips to the Banbury machine. The conveyor system occasionally becomes overloaded with scrap, thus requiring the operator to divert some of the scrap material into 55 gallon drums for temporary storage.

As the conveyor supply of scrap tile diminishes, the operator empties the drums of scrap tile back onto the conveyor belts. Also, the operator transports drums of scrap to and from the warehouse. The exhaust ventilation for the recycling line consists of an open duct which returns room air to the roof.

3. Ink Mixing Room

One employee spends 15-20 minutes per day in the ink mixing room (300 ft^2) preparing formulations. The room contains drums of ink and mineral spirits. Although the room has no exhaust ventilation, there is a wall-mounted air conditioner which the worker uses at his discretion. Also, the worker leaves the large entrance door open whenever he works in the room because of the strong odors.

The ink formulation consists of mixing inks and mineral spirits to obtain the desired color and consistency which is optically compared to the standard. Once the mixing is complete, the worker leaves this room for the rest of the day.

B. Evaluation Design/Methods

1. Evironmental/Medical Survey

On June 27, 1978, an initial environmental/medical survey was conducted. After the opening conference, a walk-through inspection was made with both management and labor representatives. The entire plant was visited so that the NIOSH representatives would better understand the general operation. The specific departments identified as being potentially hazardous were the ink room, process room, mill room, and the recycling room.

2. Environmental Air Sampling

Personnel and area samples were used to evaluate employee exposure. The personnel samples were attached to the workers' shirt collar in order to characterize a breathing zone sample. The area samples were 1.0 feet to 3.0 feet from the workers' breathing zone. Each of the sampling data tables include information denoting the types of samples collected.

Carbon Black

Carbon black dust samples were collected with mine safety appliance (MSA)® Model G battery operated personnel sampling

pumps. A known volume of air is drawn through a casette containing a tared 37 millimeter (mm) diameter 2.0 micrometer (um) pore size polyvinyl chloride (PVC) filter (type FWSB). The pump flow rates were calibrated daily and operated at 1.5 liters per minute to collect 2 four-hour samples. The analytical method consists of weighing the filter in a clean tared crucible. The crucible and filter were placed in a muffle furnace and the filter was ashed by gradually raising the temperature to 800°C. After ashing, the crucibles were re-weighed. The loss on ignition represents the weight of the filter plus the carbon black contained in the sample.

Benzene-Soluble Fraction and Polynuclear Aromatic Hydrocarbons

Collection of these two contaminants is accomplished by using a MSA pump in conjunction with a sampling cassette containing a 37-mm diameter/0.8 um pore size glass fiber silver membrane filter. The sampling train (pump and filter) is calibrated daily and operated at 1.5 lpm for about eight hours.

Benzene-Soluble Fraction

The samples were analyzed by NIOSH Physical and Chemical Method #217 (P&CAM). The particulate matter on the filters was extracted with benzene ultrasonically. After extraction, the benzene solution was filtered and evaporated to 1.0 milliliter (ml). An aliquot was evaporated in a tared Teflon boat; the weight gain is due to the benzene soluble residue in one-half the sample.

PNA

The samples were analyzed by reverse-phase high pressure liquid chromatography. Analytical procedures involve the application of a methanol/water solvent gradient. The ultraviolet detector scans the sample at 365 nanometers (nm) and 280 nm simultaneously, which aids in compound identification. (P&CAM 206 modified technique)

Identification of specific peaks in the chromatograms derived from the samples were compared with those of known standard compounds. The limits of detection listed in Table II apply to a 1.0 microliter (ul) injection from a 1.0 ml sample. The detection limits are different because all samples were analyzed using a large injection volume to increase sensitivity. The reported limit of detection may vary between samples due to injecting different sample volumes.

Solvents (Mineral Spirits and Benzene)

A sampling train consisting of a Sipin® vacuum pump and a 150 milligram activated charcoal tube is used to collect a known volume of air. Air contaminants are adsorbed to the charcoal grains and later analyzed. The charcoal tubes, which have two sections, are separately desorbed in 1.0 ml of carbon disulfide containing dodecane as an internal standard and analyzed by gas chromatography with a flame ionization detector according to NIOSH method #127 (modified).

Asbestos

The samples were collected using a sampling train with a three piece cassette, 37-mm diameter/0.8 um pore size mixed cellulose membrane filter (type AA). The filter is sampled open face in order to assure even dispersal of fibers on the filter. The pump was calibrated daily and operated at 1.5 lpm for a pre determined time. The sample was later analyzed by NIOSH method P&CAM #239 utilizing phase contrast microscopy.

Nuisance Dust

A personal sampling train with a tared 37-mm diameter/5.0 um pore size, tared polyvinyl chloride filter (type FWSB) or its equivalent was used to collect nuisance dust. The pump was operated at 1.5 lpm for the prescribed time or until the filter appeared to be overloading with dust particulate. The filter was subsequently analyzed gravimetrically according to NIOSH method #29. The weight of the sample was determined by subtracting the tare weight from the total weight.

Lead and Total Chromium

These metals were collected by drawing air through a 37-mm diameter/0.8 um pore size mixed cellulose ester membrane filter (type DM-800) with an MSA model G pump. The filter analyses consisted of ashing the filters with nitric acid and perchloric acid and subsequently analyzing the solution by atomic absorption spectrophotometry (NIOSH method #173).

3. Medical

On June 26, 1978 the physician examined all the medical information which OSHA officers had obtained from the President, URW Local 505, and from Kentile (Chicago) employees, ex-employees, or their next of kin.

Some death certificates were included in the Kentile file, and their contents were noted.

On June 27, 1978, the medical records of all workers included in the list supplied to NIOSH, by Local 505 President, were examined at the plant. There was free discussion of the records with the plant physician and full-time nurse. Further information was obtained from the Union's Local president.

The plant employs a full-time nurse on the day-shift, stationed in a well-equipped First Aid room.

All asbestos-exposed workers have had annual chest X-rays since 1971, and pulmonary function tests for the past five years, performed at a local clinic.

No cases of asbestosis were on record at the plant.

A physician from the local clinic performs all pre-placement physicals, annual examinations and sees all workers who have been absent from work for health reasons for periods in excess of three days.

On arrival at Kentile Floors, Inc., the medical officer asked the Illinois representative to let the workers know that a government doctor was present in the plant and was available for consultation on any work related health problems.

Of the three workers who sought this medical advice, only one had an occupational disease. He had an irritant dermatitis on his face, and more markedly, inside his elbows.

The medical officer gave the union representative a supply of "Release of Medical Information to NIOSH" forms which he was requested to distribute to all workers who believe that they are suffering from work-related disease. On completion, these forms were to be forwarded to the NIOSH physician. To facilitate this matter, a supply of self-addressed envelopes were sent to Local 505 by the medical investigator.

On receipt of fourteen completed forms, authorizing release of medical information to NIOSH, the personal physician(s) and/or medical facilities listed in these documents were contacted by letter, and all relevant medical information was requested of them. A photocopy of the signed medical-release forms accom panied each request. The plant physician sent relevant medical information on workers, as requested.

No medical reports were received on four of the workers participating in this investigation. A reply that there were no records of such a patient was received on three of them. The personal physician of the fourth man was deceased, and the disposition of his medical files was unknown.

C. Evaluation Criteria and Toxicity Data

1. Environmental

There are several criteria used to evaluate the toxic air contaminants of an employee's work environment: (1) NIOSH Criteria Documents for a Recommended Occupational Health Standard, (2) Proposed and Recommended Threshold Limit Values (TLV's), as suggested by the American Conference of Governmental Industrial Hygienists (ACGIH), 1976, (3) the OSHA Standards.

The criteria for each contaminant are based upon the current state of knowledge concerning toxicity of these substances. The criteria are designed to allow an occupational exposure for up to a 10-hour work day, 40-hour work week as a time-weighted average (TWA) over a normal lifetime without the worker experiencing adverse health effects at or below the TWA.

There are some airborne contaminants for which this TWA is inadequate; consequently, the substance may be preceded by the letter "C". This letter indicates a ceiling value for a sampling interval of 30 minutes or less. The ceiling value is used to identify hazardous substances which are fast acting, and it should never be exceeded.

The criteria mentioned above have been tabulated, footnoted and compared to the OSHA Standard listed in the Code of Federal Regulations (CFR), (1978) Title 29, Part 1910, Subpart 2, Section .1000. The OSHA Standard has been cited so that the reader may see which of the standards have been exceeded. However, no discussion of the OSHA Standard, with respect to airborne levels, will be presented.

SUBSTANCE	TIME-WEIGHTED AVERAGE 8-HOUR	TIME-WEIGHTED AVERAGE 10-HOUR	CEILING VALUE	MINUTES
Carbon Black[1]		3.5mg/m^3[a] and 0.10mg/m^3 as cyclohexane extractable substances (PNA's)		
Polynuclear Aromatic[2] Hydrocarbons (PNA)		0.2mg/m^{3}as benzene extractable or 0.1mg/m^3 cyclohexane extractable fraction in the presence of specific PNA's		
Refined Petroleum Solvents[3] (Mineral Spirits or Naphtha)		350mg/m^3	1800mg/m^3	15
Benzene[4]			3.2mg/m^3	60
Asbestos[5] (fibers must be longer than 5.0 micron)		0.10 fibers/cc[b]	0.50 fibers/cc	15
Inert Nuisance Dust[6]	10mg/m^3			
Inorganic Lead[7]		0.05mg/m^3		
Total Chromium[8]		1.0ug/m^3[c]		

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a) mg/m^3 - Approximate milligrams of particulate per cubic meter of air

b) Fibers/cc - Fibers of particulate per cubic centimeter of air

c) ug/m^3 Approximate micrograms of particulate per cubic meter of air

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1. NIOSH Criteria Document (1978). The OSHA Standard (1978) is 3.5mg/m^3.

2. NIOSH has no specific criteria for each PNA. Thus, PNA's are evaluated as cyclohexane extractable substances (.10mg/m^3) in the presence of a specific substance, e.g. coal tar pitch, carbon black, etc. The OSHA standard and TLV evaluate PNA's as a benzene soluble fraction (0.20mg/m^3) for a specific substance, e.g. coal tar pitch.

3. NIOSH Criteria Document (1977). The OSHA Standard (1978) is 400mg/m^3.

4. NIOSH Recommendation Revised as a part of NIOSH testimony at OSHA hearing (1977). The OSHA Standard is 32.mg/m^3 (1978) TWA with a maximum ceiling concentration of 160mg/m^3 for 10 minutes.

5. NIOSH Criteria Document, Revised edition (1977). The OSHA Standard is 2 fibers/cc as an 8-hour TWA and 10 fibers/cc as a ceiling concentration.

6. ACGIH TLV Document (1978). The OSHA Standard is 15.0mg/m^3. (1978).

7. The OSHA Standard is 0.05mg/m^3. (1979)

8. NIOSH Criteria Document (1975). The OSHA Standard is 1.0ug/m^3. (1978)

2. Toxicity Data

Asbestos

Available studies provide conclusive evidence that exposure to asbestos fibers can cause cancer and asbestosis in man.

Asbestosis is a chronic lung disease due to inhalation of asbestos fibers and is characterized by diffuse interstitial fibrosis frequently associated with thickening of the pleura (fibrosis) and/or pleural calcification. The characteristic X-ray changes are small, irregular opacities in the lower and middle lung fields. Asbestosis is a progressive disease which may develop in seven to ten years depending upon degree of exposure and type of asbestos fiber. Usually the disease becomes evident 20-40 years after first exposure, and may progress even after exposure has ceased.

Bronchogenic carcinoma and mesothelioma occur among workers exposed to asbestos fibers. There is a marked enhancement of the rist of bronchogenic carcinoma (lung cancer) in those exposed to asbestos who also smoke cigarettes. Mesothelioma is a cancer of the lining of the lungs (pleura) or the abdominal cavity (peritoneum). Other types of cancer associated with asbestos exposure are those of the larynx and gastro-intestinal tract. All these cancers have a lengthy induction period, i.e. the time which elapses between the onset of exposure and the development of the carcinoma, usually in excess of twenty years. There are data which show that the lower the exposure, the lower the risk of developing asbestosis and cancer. NIOSH has found no evidence for a threshold, or for a "safe" level of asbestos exposure with respect to the development of cancer.

D. Evaluation Results and Discussion

1. Environmental

Four carbon black samples (personal and area) were collected at the pigment scale operations booth. Also, a bulk sample of the pigment was analyzed. It was learned that the company dilutes the carbon black with limestone in order to obtain the desired pigment concentration. An analysis of the carbon black revealed it to be 58 percent pure. None of the air samples indicated any carbon black accumulation on the filters.

Ten PNA samples (personal and area) were collected from several positions along the three lines. Another agency performed a survey in which several PNA's were identified; however, the source of contamination could not be determined. It was first suspected that carbon black might have been the source of contamination; however, this thought was discounted after viewing the operation in detail. It was attempted to sample at different positions along the line to ascertain if one specific area reflected PNA exposure. A laboratory analysis indicated that the sample chromatograms did not contain any peaks which would be interpreted as polynuclear aromatic hydrocarbon compounds.

Eight personal and area samples were collected for mineral spirits and benzene. None of these samples exceeded the NIOSH recommended standard. A bulk sample of the mineral spirits was used to identify the naphtha peaks.

Thirty asbestos samples (personal) were collected from three lines as 8-hour TWA samples and as 15 minute samples. Seven of the TWA samples exceeded the NIOSH recommended criteria of 0.10 fibers/cc. None of the samples exceeded the 15 minute sample of 0.50 fibers/cc.

Thirty-nine personal and area samples were collected for total nuisance dust exposure. None of the samples exceeded the OSHA standard or the ACGIH threshold limit value of 15.0mg/m^3 and 10.0mg/m^3 respectively.

Four samples (personal and area) were collected for the chrome yellow pigment. None of the samples exceeded the OSHA lead standard (0.05 mg/m^3) or NIOSH recommended standard for chromium (1.0 ug/m^3).

The health hazard survey attempted to evaluate all the potentially toxic chemicals on the inventory list, but attention was primarily focused on the specific chemicals cited on the health hazard evaluation request. However, since all of these chemicals are not used on a daily basis some could not be evaluated. It was also determined that dyes are not used by the company, and alpha methyl styrene is no longer used consequently, specific chemicals were evaluated based on the relative toxicity, quantity and frequency of use.

All of the employees working along the process line were observed to wear their respirators during this evaluation. Most of the employees only fastened one of the two straps, and in several cases, the employees placed a paper towel around their chin between the skin and the respirator to absorb moisture.

The employees working in the recycling area do not wear a respirator except when filling drums with excess scrap material. Neither of the workers wears safety glasses. As chips are transferred from one conveyor line to another, the chips become airborne momentarily. Several scrap chips hit the NIOSH investigators face and glasses during the day's survey. It was also observed that the guards for the conveyor system are not the same size. The conveyor line with the smaller guard rails allowed considerably more spillage of scrap material.

It was observed that as the automatic conveyor system filled the hopper car, the chemicals created a slight amount of dust some of which escaped the canopy exhaust system.

All of the chemicals are stored in the warehouse. Some of the chemicals are either animal carcinogens or suspected human carcinogens. These chemicals are not specifically identified as such or stored away from other less toxic chemicals.

There was a 2-3 inch gap between the ceiling and an I-beam structure on the locker room, thereby allowing dust to contaminate the area. This problem was corrected by the company prior to the follow-up survey.

The exhaust ducting along line 6 in the process room (Bldg 2) at the A calendar was dixconnected.

Medical

Excess cancers of the respiratory and gastro-intestinal tract have been documented in workers with significant asbestos

exposure but of the three authenticated cases of cancer revealed in this investigation (two of the larynx and one of the colon) only one should be regarded as possibly being of occupational origin. This is a case of laryngeal cancer in a worker who is reported to be a light drinker, non-smoker. Smoking and drinking have been implicated in the genesis of laryngeal cancer. This cancer has a lengthy latent period i.e., the amount of time elapsing between exposure to an occupational carcinogen(s) and the development of a tumor. One cannot be sure, in this case, what the causative agent(s) could be. Prior to his first employment at this plant, the man worked in an industry associated with the development of respiratory-tract cancers. The other two workers were not process operators; therefore, they would have comparatively light exposure to asbestos, and there is no record of previous occupational exposure to other known, or suspected, carcinogens.

The diagnosis of asbestosis made on one worker by a physician at a local hospital was not confirmed by lung-disease experts at NIOSH's Appalachian Laboratory of Occupational Safety and Health, and the University of Cincinnati, after evaluation of the findings of all medical investigations undertaken on this man.

The diagnoses recorded on the remaining seven workers included dermatitis, chronic bronchitis, diabetes and heart disease. With the possible exception of the case of dermatitis, these diseases are not considered to be caused by occupational exposures at this plant.

D. Recommendations

1. The company should review their material inventory list to determine which chemicals are potentially toxic. The toxic chemicals should be monitored periodically.

2. Employees should be instructed to fasten all straps on their respirators. Also, paper towels should not be placed between the skin and respirator because this will reduce the respirator's effectiveness.

3. Employees working in the recycling area should wear respirators when filling the drums. All employees working on or near the recycling conveyor belts should wear safety glasses with side shields to prevent eye injury.

4. The canopy exhaust system for each of the three process lines should be examined to ascertain whether the side

curtains are effectively capturing the dust generated while filling the hopper.

5. Chemicals which are carcinogens (e.g. Dianisidine Orange) or suspect carcinogens for humans and animals should be identified and stored away from non-carcinogens.

6. The ventilation exhaust system should be inspected periodically to assure proper operation.

7. For the men potentially exposed to asbestos, all work clothes should be collected in the plant shower/locker room at the end of each day, so that they can be placed in plastic bags for proper cleaning. These work clothes must not be taken home to be washed because this could expose others at home to asbestos.

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TABLE I
Summary of Air Sampling for Carbon Black
Kentile Floors
Chicago, Illinois

September 21, 1978

Sample Number	Type of Sample	Job Classification or Location	Sampling Period	Sampling Volume (Liters)	Carbon Black Concentration (mg/m3)[1]
1216	Personnel	Line #7 Pigment Scale Operator	0810-1216	342	N.D.[2]
1206	Personnel	Line #7 Pigment Scale Operator	1248-1557	279	N.D.
449	Work Area	Line #7 Pigment Scale Operator (B.Z.)[3]	0810-1212	360	N.D.
704	Work Area	Line #7 Pigment Scale Operator (B.Z.)	1212-1557	333	N.D.

1. mg/m3 - Approximate milligrams of carbon black per cubic meter of air.
2. N.D. - None Detected (Limit of Detection is 0.5 mg).
3. B.Z. - Breathing zone sample.

NIOSH Recommended Criteria (1978)-3.5mg/m^3

TABLE II

Summary of Air Sampling for Polynuclear
Aromatic (PNA) Hydrocarbons
Kentile Floors
Chicago, Illinois

September 20 - 21, 1978

Date	Sample Number	Type Sample	Job Classification Or Location	Sampling Period	Sampling Volume(Liters)	CONCENTRATION µg/sample[1] Benzo(a) pyrene	Anthracene	Phenanthrene	Pyrene	Chrysene	Benzene Soluble[2](mg/m3)
9/20	PNA-1	A[3]	Line #7 Pigment table (B.Z.)[4]	0746-1549	729	< 0.04	< 0.20	< 0.08	< 0.20	< 0.10	0.27
9/20	PNA-2	P[5]	Line #7 Mixer Operator	0805-1550	684	< 0.04	< 0.20	< 0.08	< 0.20	< 0.10	0.08
9/21	PNA-3	A	Line #7 Mixer Operator(B.Z.)	0800-1548	702	< 0.20	< 1.00	< 0.40	< 1.00	< 0.50	1.28
9/21	PNA-4	P	Line #7 Mixer Operator	0800-1548	639	< 0.05	< 0.25	< 0.10	< 0.25	< 0.13	0.37
9/20	PNA-6	A	Line #5 Pigment table (B.Z.)	0818-1558	693	< 0.04	< 0.20	< 0.08	< 0.20	< 0.10	0.28
9/20	PNA-7	P	Line #5 Mixer Operator	1242-1601	297	< 0.04	< 0.20	< 0.08	< 0.20	< 0.10	0.33
9/21	PNA-8	A	Line #5 Mixer Operator	0816-1550	684	< 0.10	< 0.50	< 0.20	< 0.50	< 0.25	0.84
9/21	PNA-9	P	Line #5 Mixer Operator	0816-1548	693	< 0.10	< 0.50	< 0.20	< 0.50	< 0.25	0.66
9/20	PNA-11	P	Line #6 Mixer Operator	0735-1550	675	< 0.10	< 0.50	< 0.20	< 0.50	< 0.25	0.56
9/21	PNA-12	P	Line #6 Mixer Operator	0741-1555	684	< 0.04	< 0.20	< 0.08	< 0.20	< 0.10	0.20

1. µg/sample - microgram of particulate per sample analyzed.
2. mg/m^3 - approximate milligrams of particulate per cubic meter of air.
3. A - Area sample.
4. B.Z. - Breathing zone sample.
5. P - Personnel sample.
6. Limits of Detection - The reported limit of detection varied between samples due to different injection volumes.

Limits of Detection[6]

Benzo (a) pyrene	- 1µg/sample
Anthracene	- 5µg/sample
Phenathrene	- 2µg/sample
Pyrene	- 5µg/sample
Chrysene	- 2.5µg/sample
Benzene Solubles	- 0.02µg/sample

TABLE III

Summary of Air Samples Collected
During Ink Mixing Operation
Kentile Floors
Chicago, Illinois

September 20 - 21, 1978

Date	Number	Type of Sample	Job Classification or Location	Sampling Period	Sampling Volume(Liters)	Concentration(mg/m^3)[1] Mineral Spirits	Benzene
9/20	1	P[2]	Ink Mixer	13:57-14:09	0.52	67.3	N.D.[3]
9/20	2	P	Ink Mixer	13:58-14:09	0.90	50.0	N.D.
9/20	3	A[4]	Desk Top	14:00-14:10	0.37	94.6	N.D.
9/20	4	A	On Top of Barrel	13:59-14:08	0.38	65.8	N.D.
9/21	6	P	Ink Mixer	12:58-1:09	0.45	166.6	N.D.
9/21	7	P	Ink Mixer	12:58-1:09	0.83	54.2	N.D.
9/21	8	A	On Top of Barrel	12:58-1:10	0.38	39.5	N.D.
9/21	10	A	Desk Top	12:58-1:11	13.0	82.7	0.15

1. mg/m^3 - Approximate milligrams of particulate per cubic meter of air.
2. P - Personnel sample.
3. N.D. - None detected.
4. A - Area sample.

Limits of Detection:
Mineral Spirits - 0.01mg
Benzene - 0.001mg

NIOSH EVALUATION CRITERIA
1. Minerals Spirits (15min. Ceiling Conc.) - $1800mg/m^3$
2. Benzene - $3.2mg/m^3$

TABLE IV

Summary of Personnel Air Samples
Collected for Asbestos
Kentile Floors
Chicago, Illinois

September 20-21, 1978

Date	Sample Number	Job Classification or Location	Sampling Period	Volume(liters)	Concentration(Fibers/cc)[1]
9/20	41*	Line #6 Asbestos Weigher	0745-0800	22.5	N.D[2] *
9/20	42	Line #6 Resin Scale Operator	0725-1545	690.	0.02
9/20	43*	Line #6 Mixer Operator	1320-1335	22.5	N.D. *
9/20	1	Line #7 Resin Scale Operator	0725-1609	735.	0.41
9/20	2	Line #7 Scrap tile loader	0732-1605	712.	0.11
9/20	4	Line #7 Resin Scale Operator	1047-1057	15.0	0.61
9/20	5	Line #7 Scrap tile loader	1038-1056	27.0	N.D.
9/20	6	Line #7 Scrap tile loader	1510-1529	19.5	0.27
9/20	7	Line #7 Resin Scale Operator	1523-1542	28.5	0.19
9/21	8	Line #7 Resin Scale Operator	0748-1600	682.	0.29
9/21	9	Line #7 Scrap Tile loader	0751-1553	675.	0.13
9/21	10	Line #7 Pigment Scale Operator	0810-1557	637.	0.02
9/21	11	Line #7 Mixer Operator	0800-1548	660.	0.05
9/21	14*	Line #7 Resin Scale Operator	1011-1026	22.5	N.D. *
9/21	15*	Line #7 Scrap tile loader	1014-1029	22.5	N.D. *
9/21	16*	Line #7 Mixer Operator	1031-1046	22.5	N.D. *
9/21	21*	Line #5 Scrap tile loader	0958-1018	30.0	N.D. *
9/21	22*	Line #5 Resin Scale Operator	0957-1014	25.5	N.D. *
9/21	23*	Line #5 Scrap tile loader	1505-1520	22.5	N.D. *

1. Fibers/cc - Fibers of asbestos per cubic centimeter of air.
2. N.D. - None detected (Limit of detection is 4500 fibers per filter)
* - Approximately 15 minute sample

NIOSH Criteria:
1. 8-Hr time weighted average 0.1 Fibers/cc
2. 15-minute ceiling concentration-0.5 fibers/cc

TABLE IV (continued)
Summary of Personnel Air Samples
Collected for Asbestos
Kentile Floors
Chicago, Illinois

September 20-21, 1978

Date	Sample Number	Job Classification or Location	Sampling Period	Sampling Volume(liters)	Concentration(Fibers/cc)[1]
9/20	24*	Line #5 Resin Scale Operator	1508-1522	21.0	N.D.[2]*
9/20	25	Line #5 Scrap tile loader	0800-1606	630	0.08
9/20	26	Line #5 Utility Man	1304-1608	277	0.07
9/21	27*	Line #5 Scrap tile loader	1013-1028	22.5	N.D. *
9/21	28*	Line #5 Resin Scale Operator	1032-1048	24.0	0.19 *
9/21	29	Line #5 Mixer Operator	0816-1548	637.	0.04
9/21	30*	Line #5 Mixer Operator	1037-1054	25.5	N.D. *
9/21	31	Line #5 Utility Man	0830-1604	615	0.05
9/21	33	Line #5 Scrap tile loader	0751-1604	675	0.05
9/21	34	Line #5 Resin scale Operator	0745-1602	682.	0.08
9/21	35*	Line #5 Scrap tile Loader	1058-1114	24.0	N.D. *

1. Fibers/cc - Fibers of asbestos per cubic centimeter of air.
2. N.D. - None detected (Limit of detection is 4500 fibers per filter).
* - Approximately 15 minute sample.

NIOSH CRITERIA:
1. 8-hr time weighted average - 0.1 fibers/cc
2. 15-minute ceiling concentration - 0.5 fibers/cc

TABLE V

Summary of Air Sampling for TOTAL DUST

Kentile Floors

Chicago, Illinois

September 20-21, 1978

Date	Sample Number	Type Sample	Job Classification or Location	Sampling Period	Volume(Liters)	Concentration(mg/m^3)[1]
9/20	F2915	P[2]	Line #7 Resin Scale	0725-1609	711	0.77
9/20	F2908	P	Line #7 Scrap tile loader	0732-1605	657	0.68
9/20	D713	P	Line #7 Pigment Scale Operator	0751-1602	675	4.53
9/20	D719	P	Line #7 Pigment Scale Operator	0751-1226	414	2.73
9/20	D699	P	Line #7 Pigment Scale Operator	1304-1602	261	9.27
9/20	F2752	A[3]	Line #7 Pigment table (B.Z.)[4]	1230-1549	297	3.03
9/20	D1226	A	Line #7 Pigment table (B.Z.)	0746-1549	729	0.74
9/20	D710	A	Line #7 Pigment table (B.Z.)	0746-1252	369	1.27
9/20	D709	A	Line #7 Pigment table (B.Z.)	1259-1549	252	1.51
9/20	F2759	P	Line #7 Utility Man	0801-1559	657	3.09
9/20	D1224	P	Line #7 Mixer Operator	0936-1550	684	0.26
9/20	F2914	P	Line #5 Resin Scale Operator	0747-1612	630	0.76
9/20	F2770	P	Line #5 Scrap tile loader	0800-1606	576	0.90
9/20	D1227	P	Line #5 Pigment Scale Operator	0806-1555	369	0.95
9/20	D1210	P	Line #5 Pigment Scale Operator	0806-1253	369	0.57
9/20	D710	P	Line #5 Pigment Scale Operator	1253-1555	270	1.07
9/20	D718	A	Line #5 Pigment table (B.Z.)	1256-1558	288	1.01
9/20	D705	A	Line #5 Pigment table (B.Z.)	0818-1250	405	0.72
9/20	D717	A	Line #5 Pigment table (B.Z.)	0818-1558	333	1.50
9/20	F2904	A	Line #5 Pigment table (B.Z.)	0818-1558	333	1.41
9/20	F2757	P	Line #5 Utility Man	0835-1608	621	1.21
9/20	D1218	P	Line #5 Mixer Operator	1242-1601	297	1.01

1. mg/m^3 - Approximate milligrams of contaminant per cubic meter of air.
2. P - Personnel sample.
3. A - Area sample
4. B.Z. - Breathing zone sample.

ACGIH TLV:
1. Total nuisance dust - 10.0 mg/m^3

TABLE V (continued)

Summary of Air Sampling for TOTAL DUST

Kentile Floors

Chicago, Illinois

September 20-21, 1978

Date	Sample Number	Type Sample	Job Classification or Location	Sampling Period	Sampling Volume(Liters)	Concentration(mg/m3)[1]
9/20	D453	P[2]	Line #6 Resin Scale Operator	0725-1545	705.	1.69
9/20	D433	P	Line #6 Pigment Scale Operator	0730-1545	697.	2.61
9/20	D706	P	Line #6 Mixer Operator	0950-1550	427.	1.01
9/21	F2901	P	Line #7 Resin Scale Operator	0748-1600	660.	0.80
9/21	F2907	P	Line #7 Scrap tile loader	0751-1553	652.	0.69
9/21	F2906	P	Line #7 Pigment Scale Operator	0810-1557	697.	1.29
9/21	F2751	P	Line #7 Mixer Operator	0800-1548	705.	2.61
9/21	F2769	P	Line #7 Utility Man	0813-1550	630.	3.68
9/21	F2900	P	Line #6 Resin Scale Operator	0737-1550	705.	7.25
9/21	F2893	P	Line #6 Scrap tile Operator	0736-1550	697.	4.06
9/21	F2763	P	Line #6 Pigment Scale Operator	0734-1550	609	5.06
9/21	F2897	P	Line #5 Resin Scale Operator	0745-1602	657.	0.68
9/21	F2754	P	Line #5 Scrap tile loader	0845-1604	547.	0.79
9/21	F2771	P	Line #5 Utility Man	0830-1604	615.	1.41
9/21	F2899	P	Line #5 Pigment Scale Operator	0818-1600	682	0.72
9/21	F2765	P	Line #5 Mixer Operator	0816-1550	690	5.36
9/20	F2892	A[3]	Recycling Operator	0845-1545	630	3.73

1. mg/m^3 - Approximate milligrams of contaminant per cubic meter of air.
2. P - Personnel sample.
3. A - Area sample.

ACGIH TLV:
1. Total nuisance dust - 10.0 mg/m^3

TABLE VI

Summary of Air Sampling for Lead and Total Chromium
Kentile Floors
Chicago, Illinois

September 21, 1978

Sample Number	Type of Sample	Job Classification or Location	Sampling Period	Sampling Volume(Liters)	Concentration (mg/m^3)[1] Lead	Concentration (mg/m^3)[1] Total Chromium
1202	Personnel	Line #5 Pigment Scale Operator	0805-1236	369	N.D.[2]	N.D.
440	Personnel	Line #5 Pigment Scale Operat	1236-1558	306	0.01	N.D.
435	Area	Line #5 Pigment Table (B.Z.)[3]	0818-1236	387	N.D.	N.D.
446	Area	Line #5 Pigment Table (B.Z.)	1236-1600	306	0.02	N.D.

1. mg/m^3 - Approximate milligrams of contaminant per cubic meter of air.
2. N.D. - None detected (Limit of Detection for lead and total chromium are 3.0 and 5.0 microgram per sample respectively)
3. B.Z. - Breathing zone sample.

NIOSH RECOMMENDED CRITERIA:
1. Lead (1978)-0.1mg/m^3
2. Total Chromium (1975) -1.0 $\mu g/m^3$