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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-94-253

ARMSTRONG CORK COMPANY
JACKSON, MISSISSIPPI

DECEMBER 1975

I. TOXICITY DETERMINATION

The National Institute for Occupational Safety and Health conducted a health hazard evaluation of vinyl asbestos tile manufacturing operations at the Armstrong Cork Company during the period December 11-12, 1974 and July 14-16, 1975. Based upon the results of these environmental and medical investigations the following determinations are made:

- (1) Exposure to airborne chrysotile asbestos in excess of the proposed OSHA standard (0.5 fiber/cc) was demonstrated for 3rd floor operators, exposure levels measured during maintenance of the "Asbestos Shredder" approach the proposed "ceiling" limit.
- (2) The potential for exposure to trace concentrations of airborne vinyl chloride monomer was demonstrated at operations throughout the process, but primarily for the resin weigher (3rd floor) and the mixer operator (2nd floor) during cleaning of the mixers. Some levels were above that recommended by NIOSH (0.2 ppm), but none exceeded the existing OSHA standard of 1.0 ppm. Exposure to vinyl chloride carries a significant risk for developing angiosarcoma of the liver (cancer of the liver).
- (3) Worker exposures to other toxic materials contained in the formulation and process operations were below levels believed to be potentially toxic. Substances evaluated included dusts containing trace amounts of free silica, limestone, trace metals - barium, lead, chromium, zinc and titanium, and the organic solvent methyl chloroform.

It should be noted that with certain tile formulations which employ totally "fresh" to "mix-in" or scrap tile components, somewhat higher concentrations of the toxic substances described above are likely to occur. During the time of the survey, a high proportion of "mix-in" component was used in the tile formulated.

- (4) Review of plant medical records which contained chest x-rays and pulmonary function tests (1973-74) along with results of NIOSH administered medical interviews of the current employee work force

(having a mean length of employment of 10 years) revealed no findings suggestive of asbestosis, mesothelioma, or lesions suggestive of lung cancer; nor were any cases of deaths from solvent intoxication discovered as alleged in the request. It should be noted that the malignant manifestations of asbestos exposure (mesothelioma and lung cancer) may take 10-40 years to develop after the exposure has ceased.

- (5) The most common complaint from employees (cough and sputum production with or without shortness of breath) is believed due to chronic bronchitis resulting from cigarette smoking. 70% of the work force interviewed are smokers of long standing and the incidence of lung cancer among smokers exposed to asbestos is many times greater than that among non-smokers exposed to asbestos. Company medical records reviewed revealed one case of lung cancer in a heavy smoker.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Health Hazard Evaluation Toxicity Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, Fifth and Walnut Streets, Cincinnati, Ohio 45202.

Copies have been sent to:

- (a) The Armstrong Cork Company
- (b) United Rubber Workers International Union
- (c) United Rubber Workers Local Union
- (d) U.S. Department of Labor, Region IV
- (e) NIOSH, Region IV

For purposes of informing the affected employees of the determination the employer shall upon its receipt post a copy of the determination for a period of 30 calendar days at or near the work place(s) of affected employees. The employer shall take steps to insure that the posted determination is not altered, defaced, or covered by other material during such period.

III. INTRODUCTION

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

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of the United Rubber Works International Union in Akron, Ohio to evaluate potential health hazards in the production of vinyl asbestos floor tile at the Armstrong Cork Company in Jackson, Mississippi.

The request alleged that many workers in this plant have had high exposures to asbestos and vinyl chloride monomer; that there have been reported deaths from lung cancer, and that workers were currently hospitalized for lung disease and other systemic ailments. Further that there was one reported death due to an acute solvent exposure.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

The Armstrong Cork Company has manufactured excelon tile (vinyl asbestos tile) at this plant since 1954. A variety of materials are mixed in the formulation of the tile, but in general these materials can be classified into two portions: (1) a "filler" portion (the largest amount by percent) consisting primarily of limestone and chrysotile asbestos; small amounts of pigments for coloration and mottle are used which contain some heavy metals. (2) a binder portion consisting of various resins (including polyvinyl chloride co-polymer powdered resin), plasticizers, and stabilizers containing some heavy metals.

Specific formulations which are proprietary are mixed in batch proportions on the third floor of the facility, dumped into heated mixers on the second floor, and the molten masses milled, patterned, cut and packaged on the first floor. Small amounts of inks with specific coloration are printed onto some tile surfaces on the first floor. For roll cleaning purposes required by pattern changes the solvent 1,1,1 trichloroethane (methyl chloroform) is applied in copious amounts.

The plant operates on a 2-shift basis from 7:30a.m. to 3:30 p.m. and from 4:00 p.m. to 12 midnight, 5 or 6 days a week.

The plant employs about 90 people, approximately 35 in the areas and operations identified in the request as described above.

B. Evaluation Progress and Design

An initial observational and environmental survey was conducted by NIOSH industrial hygienists Jerome P. Flesch, Paul Roper and Raymond Ruhe during the period December 11-12, 1974.

An opening conference with management and a local union representative was conducted to describe the nature of the request and scope of activities required to be pursued in the investigation. During this initial discussion period, management denied all allegations tendered by the International Union as submitted in the request form.

Subsequently on December 11 a walk-through inspection of the facility and operations was completed to obtain an employee-job profile and assess the potential for employee exposure to the various toxic substances associated in the process operations.

Based upon this information, a detailed environmental survey was performed on December 12 employing personal and area air sampling of potentially toxic airborne contaminants during both work shifts. Additionally non-directed medical questionnaires were administered to employees monitored during this period.

Third floor operations encompass the batch preparation - weighing and conveying of materials for dumping to mixers on the second floor. Potential for employee exposure to excessive dusts containing asbestos, limestone, free silica and pigments and stabilizers containing heavy metals and to vinyl chloride monomer from PVC resin was judged to exist and therefore appropriate sampling performed to characterize the degree of exposure.

Second Floor operations encompass the enclosed mixing of batch materials and the transformation with applied heating to a "dust-free" molten mass. Potential for exposure to vinyl chloride monomer was assessed for operators on this floor. There is no exposure to asbestos or dust on this floor.

First floor operations included the milling, shaping, formulation and application of mottle and inks to the molten mass, and solvent cleaning of pattern and ink rollers. Potential for exposure to dusts containing metals in the mottle mix operation, vinyl chloride monomer, and methyl chloroform vapor was determined for associated operators on this floor.

A follow-up medical survey was performed by NIOSH physician, Robert Rostand, M.D. during the period July 14-16, 1975 to review corporate medical records which included pulmonary function tests and chest x-rays and to conduct more detailed medical interviews with exposed employees.

C. Evaluation Methods

1. Environmental

Asbestos: Personal breathing zone (BZ) air samples were collected on Millipore 37 mm "AA", 0.8 micron pore size, cellulose ester membrane filters in open face cassettes with filter face oriented down using calibrated MSA Model G battery-powered pumps at an air flow rate of 2.0 liters of air per minute. Analysis was accomplished by phase contrast microscopy for asbestos fiber concentration and reported as number of fibers greater than 5 microns in length per cubic centimeter of air sampled.

Total Dust and Metals: Personal breathing zone (BZ) air samples were collected on pre-weighed Millipore 37 mm "AA" filters in 3-piece cassettes, center plug removed, with filter face oriented down using MSA Model G battery-powered pumps at an air flow rate of 2.0 liters of air per minute. Total dust analyses were obtained by gravimetric (post-sample weighing) methods; trace metal (zinc, barium, lead, chromium, titanium) determinations were performed using NIOSH P&CAM #173 (atomic absorption spectrophotometry).¹

Total and Respirable Dust Free Silica: Area samples were collected on Millipore 37 mm PVC filters in 3-piece cassettes (with 1/2 inch steel cyclone for "respirable" samples) using 110 volt AC powered Gast Model 31 pumps at a flow rate of 9.0 liters of air per minute controlled by a critical orifice. Dust analyses were by gravimetric methods. Free silica analysis determination was accomplished by NIOSH P&CAM #106 (colorimetric method).¹

Vinyl Chloride Monomer: Personal breathing zone air samples were collected in glass tubes containing activated charcoal using battery-powered Sipin pumps at an air flow rate of approximately 50 cubic centimeters per minute. Analysis was accomplished according to NIOSH P&CAM #178 (desorption with carbon disulfide; gas chromatography).¹

Methyl Chloroform: Personal breathing zone air samples were collected in glass tubes containing activated charcoal using battery-powered Sipin pumps at an air flow rate of approximately 50 cubic centimeters per minute. Analysis was accomplished according to NIOSH P&CAM #127 (desorption with carbon disulfide; gas chromatography).¹

D. Evaluation Criteria

Asbestos: Asbestos is a generic term that applies to a number of naturally occurring, hydrated mineral silicates incombustible in air and separable into filaments. The most widely used in industry in the United States, and that used in this facility is chrysotile ($3 \text{ Mg}^{0.2} \text{ SiO}_2 \cdot 2 \text{ H}_2\text{O}$). Exposure to asbestos dust may result in a debilitating lung disease (asbestosis), mesothelioma and lung cancer. These malignant changes (lung cancer and mesothelioma) as well as asbestosis may develop 10-40 years after the exposure to asbestos dust has ceased. Review of the most recent criteria has resulted in OSHA's proposed standard to limit the permissible exposure to asbestos to 0.5 fiber/cc for an 8-hour TWA and to reduce the permissible "ceiling" exposure to 5 fibers/cc for any period not exceeding 15 minutes.²

Free Silica: Exposure to dusts containing free crystalline silica may result in the progressive lung disease "silicosis" which is characterized symptomatically by difficulty in breathing, cough, and wheezing. Dusts containing less than 1% free silica are generally classified as nuisance dusts posing no health hazard to this disease etiology. NIOSH has recommended in its Criteria Document (3) that employee exposure to respirable free silica be limited to 50 micrograms per cubic meter of air based on a full shift sample up to a 10-hour work day, 40-hour work week.

Metals: Environmental criteria recommended by the American Conference of Governmental Industrial Hygienists (4) for employee exposure to the trace toxic metals reported contained in the pigments and stabilizers utilized in this manufacturing process are summarized below:

<u>Substance</u>	<u>8-hour TWA Concentration</u>
Lead, inorg. fumes/dusts	0.15 mg/M ³
Barium, sol. compds.	0.5
Chromium, sol. compds. as CR	0.5
Chromates, as CrO ₃	0.1

Nuisance Dusts: Limestone (major percent of the "filler" employed in tile), titanium dioxide (pigment), and zinc (stabilizer) are classified in this category. Nuisance dusts have a long history of little adverse effect on

lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. A TLV of 10 mg/M³ is recommended to reduce unpleasant deposits in the eyes, ears, nasal passages, and permit adequate visibility and prevent injury to the skin or mucous membranes by chemical or mechanical action.

Vinyl Chloride Monomer: Vinyl chloride is considered a carcinogenic agent. It is suspected of being an etiologic agent in the development of angiosarcoma of the liver (a rare form of liver cancer). As stated in NIOSH's Recommended Standard for Occupational Exposure to Vinyl Chloride⁽⁵⁾, "there is probably no threshold for carcinogenesis although it is possible that with very low concentrations, the latency period might be extended beyond the life expectancy." In view of these considerations and NIOSH's inability to define a safe exposure level the concept of a threshold limit for vinyl chloride gas in the atmosphere is rejected. As a result, the NIOSH Recommended Standard for Occupational Exposure to Vinyl Chloride states that exposure to vinyl chloride monomer should not exceed levels that are detectable by the recommended methods of sampling and analysis.

Methyl Chloroform: Exposure to vapor of methyl chloroform as with most organic solvents has produced mild anesthetic effects and in very high concentrations headaches and lassitude. The American Conference of Governmental Hygienists has established its Threshold Limit Value at 350 ppm. The high rate of metabolism of this compound and that fact that over 98% is excreted in the breath may be the reason for its low toxicity.

E. Evaluation Results and Discussion

1. Environmental Evaluation

In-depth environmental airborne sampling of workers' exposures to the myriad of substances routinely employed in the process was conducted on the two consecutive workshift periods on December 12, 1974.

(a) 3rd Floor Operations

Most materials which make up the formulation for vinyl asbestos tile were stored in paper or plastic bags on the third and second floors. Operators were observed to manually or mechanically weigh, convey and formulate the specific batch mix via a series of buckets filled at dump stations. PVC resin was also delivered by pneumatic conveyance from a storage silo outside the main building. Local exhaust ventilation was applied at the dump stations. Nonetheless, considerable dust, airborne and settled was observed in the area. An "asbestos shredder" enclosure had been constructed a few months prior to the survey and appeared to considerably limit the potential for airborne asbestos exposure in the general area. No respiratory protection was used in these general areas (all three floors) except during the periodic maintenance of the walk-in "asbestos shredder" enclosure.

Tables 1 and 2 summarize the results of the environmental air sampling obtained during normal operations on the third floor.

Personal breathing zone chrysotile asbestos fiber concentrations ranged from 0.04 to 1.41 fibers/cc (20 samples). One 10-minute sample during maintenance of the "asbestos shredder" was 4.98 fibers/cc - this function occurs once or twice a workshift.

Personal breathing zone total particulate concentrations of the compounds ranged from 4.5 to 7.8 mg/M³; trace concentrations of barium and zinc were found - lead, chromium and titanium were not detected.

Personal breathing zone vinyl chloride concentrations ranged from non-detected to 0.48 ppm (4 of 16 samples were above the detection limit of 0.2 ppm).

General area samples resulted in concentrations of total particulate from 1.0 to 6.5 mg/M³ and of respirable particulate from 0.5 to 1.2 mg/M³. Bulk samples of limestone and chrysotile asbestos contained less than 1% free crystalline silica. Since the free silica content was less than 1%, the nuisance dust criteria for respirable dust was appropriate for the evaluation.

(b) 2nd Floor Operations

Personal breathing zone vinyl chloride concentrations shown in Table 3 were all less than the detection level of 0.2 ppm except for one 20-minute sample (0.91 ppm) during cleaning of a mixer at the end of the workshift.

Total particulate concentrations of the mixer operators ranged from 1.7 to 3.0 mg/M³, with only trace amounts of zinc detected.

(c) 1st Floor Operations

Personal breathing zone vinyl chloride exposures were not detected except for the mill operator - 2 of 14 samples detected with a high of 0.66 ppm.

Personal breathing zone methyl chloroform concentrations ranged from 0.8 to 78 ppm (14 samples).

Mottle line operators were exposed to concentrations of total particulates ranging from 3.2 to 4.6 mg/M³; no trace metals detected.

(d) Summary

Exposure to airborne chrysotile asbestos in excess of the proposed OSHA standard (0.5 fiber/cc) was demonstrated for third floor operators; exposure levels measured during maintenance of the "asbestos shredder" approach the proposed "ceiling" limit.

The potential for worker exposures to vinyl chloride monomer was demonstrated for operators at operations throughout the process, primarily to the resin weigher (3rd floor) and to the mixer operator (2nd floor) while cleaning mixers. All levels observed were, however, less than the existing OSHA standard of 1.0 ppm for vinyl chloride.

The exposure levels obtained for total and respirable particulates containing trace toxic components including heavy metals and free silica were below levels believed to be potentially toxic.

Exposures to the solvent methyl chloroform used in roll changing during the survey were not believed excessive.

It should be noted that with certain tile formulations which employ totally "fresh" or a high proportion of "fresh" to "mix-in" or scrap concentrations of toxic substances measured, eg. chrysotile asbestos and vinyl chloride, are likely to occur. During the time of this survey formulations utilized a high proportion of "mix-in" components.

2. Medical Evaluation

At the time of the environmental evaluation, December 12, 1974, non-directed medical questionnaires were administered to 20 workers environmentally monitored. Some workers reported complaints of burning eyes, nasal stuffiness, headaches, dizziness and difficulty in breathing. Eleven workers reported no health problems related to their work. As a result of this review, it was decided that indepth medical interviews - physical examinations of workers would be performed by a NIOSH physician.

Information obtained during the initial visit further revealed the availability of company medical records which included x-rays and pulmonary function tests on all employees over the last three years. Review of these records and records of 11 employees on a list provided by the local union as having health problems which they believed might be related to the working environment were deemed necessary to complete the medical evaluation. Accordingly on July 14-16, 1975 Robert A. Rostand, M.D. performed the follow-up medical survey.

Since 1972, in accordance with OSHA requirements regarding industrial exposure to asbestos, the Armstrong Cork Company has conducted annual pulmonary function tests and chest x-rays on all employees. In addition, since February 1974, the Company has conducted industrial hygiene surveys to monitor employee exposure to vinyl chloride monomer. These surveys are conducted on a monthly or quarterly basis depending upon location.

All employees on the 7:00 a.m. - 3:30 p.m. and 3:30 p.m.- 11:30 p.m. shift whose job is closely concerned with the manufacture of tile were interviewed. The members of the Inspection Department were not interviewed but their chest x-ray and pulmonary function test results were reviewed. Twenty-four (24) persons were interviewed.

The medical interviews were conducted in a nondirected manner and all employees considered the work day, when the medical survey was conducted, as a usual work day. All employees interviewed were men between the ages of 30-60 years of age and had a mean length of employment of 10 years. Approximately 30% were non-smokers and 70% were smokers of long-standing. All employees considered themselves in good health.

Most employees considered the plant conditions improved compared with when they first started working. Men considered the plant much less dusty.

The most common complaint from employees were cough and sputum production with or without shortness of breath. Significantly, these symptoms were elicited only from men who smoked cigarettes. No persons complained of

dyspnea alone, chest pain or long-standing chronic pulmonary disease, suggesting asbestosis or mesothelioma. Three persons noted transient dizziness or feeling "high" which they related to methyl chloroform which is used to clean printing rollers. No recent cases of solvent intoxication requiring hospitalization were discovered. However, several years ago two persons were hospitalized for solvent intoxication but these two cases were the only such cases discovered. An occasional skin rash was noted.

Review of plant medical records revealed only one case of lung cancer in a heavy smoker. The only other malignancy found was Hodgkin's disease in a 54 year old man who has since been treated and is currently working for Armstrong Cork. Other medical illness revealed: one case of a ruptured berry aneurysm, five cases of atherosclerotic heart disease and peripheral vascular disease; one case of emphysema and one case of severe long-standing hypertension. No cases of asbestosis or mesothelioma were discovered. No cases of deaths from solvent intoxication were discovered and to the best recollection of representatives of labor and management, none had ever occurred.

The review of chest x-rays for 1973-74 revealed no cases of asbestosis, mesothelioma or lesions suggestive of lung cancer. The most common abnormality was parenchymal and/or lymph node calcifications indicative of healed granulomatous disease. The difference between tuberculosis and histoplasmosis is impossible to make by chest x-ray alone, but both are in the differential diagnosis of the above roentgenographic abnormalities.

Review of the pulmonary function data from 1973-74 revealed that almost all employees participated in the required studies. Spirograms were reviewed and forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_{1.0}) were calculated. By and large only minor abnormalities were found but since only one forced expiratory maneuver was performed, these abnormalities are difficult to evaluate. It is common practice to perform five such expiratory maneuvers since a "learning phenomenon" occurs and since only the best tracing is selected. No significant correlation between length of employment and decrement in FVC (an indication of restrictive lung disease seen in asbestosis) could be made.

Based upon employee interviews, pulmonary function tests and chest x-ray results, it is believed that the frequently noted symptoms of cough, sputum production and dyspnea are most likely due to chronic bronchitis resulting from cigarette smoking.

F. Recommendations

The health hazards of working with asbestos and vinyl chloride are well known and every effort should be made to keep employee exposure to these agents at a minimum.

1. Specifically improved enclosures, increased ventilation and regular maintenance of local exhaust systems at material dump stations to capture fugitive dusts and vapors on the third floor and of heated mixes on the second floor is recommended.

2. Approved respiratory protection for exposure to asbestos and vinyl chloride should be provided to and worn by operators while performing maintenance and cleaning at the asbestos shredder and heated mixers.

3. Periodic environmental and medical monitoring of operations and employees according to recommendations contained in NIOSH's Criteria for a Recommended Standard for Asbestos and Vinyl Chloride should be adhered to.

V. REFERENCES

1. NIOSH Manual of Analytical Methods; USDHEW, CDC, NIOSH - 1974, Pub No 75-121
2. Federal Register 40, No. 197 (Oct. 9, 1975): Occupational Exposure to Asbestos. Notice of Proposed Rule Making.
3. Criteria for a recommended Standard...Occupational Exposure to Crystalline Silica; USDHEW, CDC, NIOSH - 1974, Pub No 75-120
4. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with intended changes for 1975. ACGIH.
5. NIOSH Recommended Standard for Occupational Exposure to Vinyl Chloride, May 1974

VI. AUTHORSHIP

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TABLE 1

Summary of 3rd Floor Operators' Breathing Zone
Exposure to Airborne Toxic Substances
2nd & 3rd Shifts/December 12, 1974

<u>Operator</u>	<u>Sampling Period</u>	<u>Asbestos fibers/cc</u>	<u>Vinyl Chloride ppm</u>	<u>Total Particulate mg/M³</u>	<u>Ba</u>	<u>Zn mg/M³</u>	<u>Pb,Cr,Ti</u>
Raw Material Supplier #1	855-1110 1110-1330 1330-1525 1500-1510	0.50 0.68 0.68 4.98	N.D. N.D. N.D. (Asbestos Shredder Maintenance)	N.S. (not sampled)			
RMS #2	1825-2240	0.33	N.D.	N.S.			
Compounder #1	901-1122 1122-1330 1330-1525	0.95 1.00 1.10	N.D.	4.5	0.03	0.02	N.D.
C #2	1848-2222	1.41	N.S.	7.8	0.17	0.10	N.D.
Batch Weigher #1	904-1143 1143-1350 1350-1508	0.18 0.04 0.08	0.22 0.33 N.D.	N.S.			
#2	1852-2220	N.A.	N.D.	N.S.			
Resin Weigher #1	912-1117 1117-1333 1335-1525	0.26 0.25 0.66	0.2 N.D. N.D.	N.S.			
#2	1815-2217	0.18	0.27	N.S.			
Assistant Resin Weigher #1	920-1113 1113-1335 1335-1525	0.23 0.19 0.19	N.D. N.D. N.D.	N.S.			
#2	1820-2212	0.26	0.48	N.S.			

N.D. - not detected

Limit of detection for vinyl chloride is 0.2 ppm

Limit of detection for metals (micrograms per filter): Ba-3.5, Cr-1.3, Pb-5.0,
Ti-20, Zn-0.2

TABLE 2

Summary of 3rd Floor General Area Concentrations
of Airborne Particulates
2nd & 3rd Shifts/December 12, 1974

<u>Location</u>	<u>Time Period</u>	<u>Respirable Particulate</u> mg/M ³	<u>Total Particulate</u> mg/M ³
Asbestos & Limestone* Dump Station	1200-1535	0.5	1.0
Asbestos & Limestone* Dump Station	1655-2226	0.5	1.3
Batch Dump Station	1200-1535	1.2	6.5
Batch Dump Station	1653-2225	0.6	3.2

*Bulk Samples Limestone (cc-109) - % Free Silica = 0.35%
 Chrysotile Asbestos (7TS3) - % Free Silica = 0.64%
 (minimum detectable quantity = 20 micrograms)

TABLE 3

Summary of 2nd Floor Operators' Breathing Zone
Exposures to Airborne Toxic Substances

<u>Operator</u>	<u>Time Period</u>	<u>Vinyl Chloride</u> ppm	<u>Total Particulate</u> mg/M ³	<u>Zn</u> mg/M ³	<u>Pb,Cr,Ti,Ba</u>
Mixer Operator #1	927-1130	N.D.			
	1130-1400	N.D.			
	1400-1525	N.C.	2.0	0.01	N.D.
#2	1835-2241	N.D.	1.7	N.D.	N.D.
	2325-2345 (cleaning mixer)	0.91	3.0	0.01	N.D.
Utility Operator #1	935-1124	N.D.	N.S.		
	1124-1335	N.D.			
	1355-1525	N.D.			
#2	1842-2220	N.D.	N.S.		

TABLE 4

Summary of 1st Floor Operators' Breathing Zone
Exposures to Airborne Toxic Substances
2nd & 3rd Shifts/December 12, 1974

<u>Operator</u>	<u>Time Period</u>	<u>Vinyl Chloride</u>	<u>Methyl Chloroform ppm</u>	<u>Total Particulate</u>	<u>Ba,Cr,Pb,Ti,Zn</u>
Mill Operator #1	1004-1220	N.D.	13.	0.6	N.D.
	1220-1404	N.D.	7.2		
	1404-1550	0.24	78		
#2	1700-1902	0.66	6.5	0.4	N.D.
	1902-2245	N.D.	<0.8		
Calendar Operator #1	1007-1220	N.D.	23	N.S.	
	1220-1406	N.D.	13		
	1406-1550	N.D.	2.2		
#2	1700-1903	N.D.	4.6	N.S.	
	1903-2247	N.D.	2.2		
Edger #1	1010-1222	N.D.	2.9		
	1222-1409	N.D.	2.7		
	1409-1526	N.D.	5.8		
#2	1900-2247	N.D.	<0.8		
Mottle Grinder #1	1029-1422			3.6	N.D.
#2	1855-2248			4.6	N.D.
Mottle Asst.	2025-2250			3.2	N.D.