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CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-8-422

BORDEN CHEMICAL COMPANY
COLUMBUS COATED FABRIC DIVISION
COLUMBUS, OHIO

SEPTEMBER, 1977

I. TOXICITY DETERMINATION

Exposure of employees to Methyl butyl ketone, Methyl ethyl ketone and Methyl isobutyl ketone in the South Printing Area at the Borden Chemical Company, Columbus Coated Fabric Division, Columbus, Ohio, were not found to be toxic under conditions observed by NIOSH Hazard Evaluation personnel during the survey of April 6-8, 1977. This determination is based upon environmental sampling (which included personal and area sampling) medical evaluation by interviews, observations of work practices and evaluation of ventilation controls. It is concluded that no new outbreak of peripheral neuropathy was found.

The production levels at the time of this survey were considered to be above the levels at the time of the alleged hazard.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

Copies of this report have been sent to:

- a. Columbus Coated Fabrics Division, Borden Chemical, Borden, Inc., Columbus, Ohio
- b. Authorized Representative of Employees
- c. U.S. Department of Labor - Region V
- d. NIOSH - Region V
- e. Amalgamated Clothing and Textile Workers Union

This report shall be posted in a prominent place(s) accessible to the workers for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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 (NIOSH) received such a request from an authorized representative of employees regarding possible exposure of workers to neurotoxins. The request stated that an employee of the Print Department was hospitalized and his condition was diagnosed as peripheral neuropathy of unknown etiology. An outbreak of peripheral neuropathy occurred at this plant in 1972-73 and was also investigated by NIOSH.^{1,2} The work force in the Print Area is comprised of 63 employees, twenty-one per shift for three shifts with the same work being accomplished on each shift. All employees in the Print Area are male.

IV. HEALTH HAZARD EVALUATION

A. Process Description

Various types of vinyl coated fabrics are made at the Columbus Coated Fabrics Plant. Their principal product is wall coverings with many elaborate printed and embossed designs. They also produce a vinyl coated cloth, used by the automobile industry for making seat covers. Large rolls of cotton "cheese" cloth, each weighing approximately 340 pounds, are received at the plant. These rolls are then placed on a calender to smooth out the fibers. At the same time the cloth is being smoothed out a coating "daub" is being mixed in another part of the plant. The daub consists of latex and liquid polyvinyl chloride.

The rolls are brought to a coating machine called a tenter. The tenter applies the initial daub on the cloth. The cloth then goes through a drying oven, is returned to the original point and a second coat of daub is applied and dried. After the second coat of daub the material is rolled and stored and used as needed.

In the Print Area, where there are eight printing machines, a roll of material is put onto the machine and started through a series of rollers. Where the two rollers come together (point station) there is a small pan running the length of the rollers, which contains the ink lacquers to be applied to the material. There are five (5) point stations (each station containing a different ink) on each printing machine with each trough or pan containing approximately one gallon of ink lacquer. The pans are filled constantly by a 55 gallon drum of ink placed near the end of the press.

While the cloth is being printed, a large surface area for the evaporation of the ink is exposed. After going through all five point stations, the material then goes through a drying oven, over a series of rolls containing cold water for cooling, rerolled and sent to other parts of the plant for processing.

B. Evaluation Design and Methods (Environmental)

Environmental monitoring was conducted for airborne concentrations of Methyl butyl ketone (MBK), Methyl ethyl ketone (MEK), and Methyl isobutyl ketone (MIBK). Personal and area samples for MBK, MEK, and MIBK were taken to determine the integrated average exposure over the work shift. A calibrated Sipin pump operating at a flow rate of 50 cubic centimeters (cc) per minute, plus activated charcoal tubes were used as the collection media and placed as close as possible to the breathing zone of each worker. The analysis on all tubes was performed with carbon disulfide desorption and gas chromatography by the Utah Biomedical Test Laboratory.

Ventilation measurements were taken at each Printing Machine using a Sierra thermolanemometer Model 440.

C. Evaluation Design and Methods (Medical)

On June 23, 1977, a survey of the Print Department workers was conducted using a short questionnaire. Since the purpose of the study was to determine whether or not there is a cluster of peripheral neuropathies within this employee group, the questionnaire was designed to compare employee's symptoms in 1973 and 1977: therefore, each individual served as his own control.

The questionnaire was administered by four NIOSH personnel. Each participant was interviewed in the Print Department near the work location but with enough distance from other persons to insure privacy.

Of the 61 workers currently employed, only four could not be interviewed due to various reasons. The participation rate was $57/61 = 93.4\%$. The summary of the survey is presented in Table III.

D. Evaluation Criteria

1. Toxicologic Effects

At one time the toxicity of Methyl-n-butyl ketone (MBK) was thought to cause no unusual health hazards. The strongest case against this compound was its capacity to cause mild transient eye irritation.^{3,4} However, recent animal studies, using various exposure routes and durations, have produced demonstrable neuropathies of the types reported in man, in at least five animal species - rats, cats, dogs, chickens and monkeys. Chickens, cats, and rats were exposed to concentrations of MBK from 200-600 parts of solvent per million parts of air (ppm) for 24 hours per day, seven days per week. Peripheral neuropathy developed in all

animals with overt clinical signs by 4-5 weeks in chickens, 5-8 weeks in cats and 11-12 weeks in rats.⁵ The paper also concluded that animal studies reveal that marginal toxic responses occur at 100 ppm, which if extended over a lifetime, could result in neurologic and pulmonary impairment.

Methyl ethyl ketone (MEK) presents a low degree of hazard to health in industrial handling. It has a low acute oral toxicity. The liquid may produce moderate skin irritation if the exposures are frequent and prolonged. Eye contact may cause marked irritation of the eyes and mucous membranes. According to animal experiments MEK in high concentrations (10,000 ppm for 4-5 hours) causes narcosis, and congestion of the liver and kidneys. These concentrations are unlikely to occur in the industrial environment since 350 ppm of MEK in the air would be intolerably irritating.^{3,4}

Methyl isobutyl ketone (MIBK) presents a low degree of hazard to health in industrial handling. It has a low single dose oral toxicity. When in contact with the eyes it may cause transient irritation and swelling. Repeated prolonged skin contact may result in dermatitis. MIBK is apparently not absorbed through the skin in acutely toxic amount. Inhalation of MIBK, because of its warning properties, does not constitute a health problem. However its vapors when breathed in high concentrations can cause narcosis, even death.^{3,4}

2. Environmental Criteria

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by various sources. These limits represent conditions under which it is believed that nearly all workers may be repeatedly exposed to a substance on an 8-hour per day, 40-hour per week basis without adverse effects. The criteria used in this investigation were taken from the following sources: (1) Threshold Limit Values (TLV's) for chemical substances as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1976⁵, and (2) Occupational Health Standards as promulgated by the U.S. Department of Labor (Federal Register, 29 CFR 1910, January 1, 1976⁶).

| Substance* | TLV/ACGIH | | OSHA Standard | |
|------------------------|--------------------------|-----------|-----------------------|---------|
| Methyl butyl ketone | 100 mg/M ³ ** | 25 ppm*** | 410 mg/M ³ | 100 ppm |
| Methyl ethyl ketone | 590 mg/M ³ | 200 ppm | 590 mg/M ³ | 200 ppm |
| Methyl isobutyl ketone | 410 mg/M ³ | 100 ppm | 410 mg/M ³ | 100 ppm |

* Concentrations are based on 8-hour Time Weighted Averages.

** Milligrams of substance per cubic meter of air.

***Parts of substance per million parts of air.

E. Evaluation Results

1. Environmental

The results of analyses of environmental air samples collected at the Columbus Coated Fabrics Plant are presented in Tables I, II, and III.

A total of 91 samples were taken for MBK, MEK, AND MIBK in the South Print Area of which 84 were personal samples and seven were area samples. All personal samples for MBK were below the NIOSH analytical limits of detection of 0.01 mg/M^3 . The concentration of MEK ranged from a low of 42 mg/M^3 (4 ppm) to a high of 388 mg/M^3 (132 ppm). Concentrations of MIBK ranged from a low of 4 mg/M^3 (1 ppm) to a high of 108 mg/M^3 (26 ppm). All concentrations of MBK, MEK, and MIBK for personal samples were below the ACGIH Threshold Limit Value and OSHA Standard.

A total of seven area samples were taken in the South Print Area for MBK, MEK and MIBK. All MBK area samples were below the NIOSH analytical limit of detection. MEK ranged from a low of 8 mg/M^3 (3 ppm) at the rest area by press H-36 to a high of 895 mg/M^3 (304 ppm) in the NIP area on press H-38. MIBK concentrations ranged from a low of 4 mg/M^3 (1 ppm) in rest area by press H-36 to a high of 350 mg/M^3 (84 ppm) in the NIP area by press H-36. Levels in the NIP area were expected to be high in this area since this is where the drums of ink are stored during operations. Anyone entering the NIP area is required to wear a respirator.

Each personal sample was taken for approximately four hours. Based on an 8-hour time weighted average, none of the samples exceeded the NIOSH Criteria or OSHA Standard.

a. Ventilation

During the initial survey of the plant in 1973 a recommendation was made to expedite emergency temporary ventilation. The ventilation system, particularly in the Print Shop area of the plant was inadequate due to poor design and maintenance. One aspect of the ventilation recommended at that time was to form a curtain of air around each machine and keep as much contamination inside the machine area as possible. After the ventilation system was corrected around each print machine, plant engineers, using a portable organic vapor analyzer made measurements around each machine starting close to the machine and working outward. When the concentration of contaminants was below the standard, yellow tape markings were placed on the floor to indicate a line of separation between high and low concentrations. This practice has OSHA approval.

A cursory check of some of the marking around the print machines indicated that the tape markings are still appropriate and do, in fact, indicate a line of separation between high and low concentrations. Ventilation measurements around the machines show an average velocity of 700 feet of air per minute (fpm). These velocities have a tendency to create eddy currents and pull vapors from the NIP area of the machine. These velocities could be reduced and accomplish the same goal and also conserve energy.

b. Respiratory Protection

During the initial survey in 1973 it was recommended that all workers in the print area be required to wear a NIOSH approved organic vapor respirator. The company has expanded this policy to include all employees during their normal course of work who are exposed to concentrations of dust, inorganic vapors, fibrous materials, and other contaminants in excess of the OSHA standards, to wear a NIOSH approved respirator. It appears that the original recommendation has been expanded to include the entire plant.

The recommendation was made initially to use respirators in lieu of the poor ventilation at that time. However the ventilation system is now operating properly and concentrations of vapors in the print area are below the ACGIH Threshold Limit Values and OSHA Standards. The need to issue respirators to everyone entering the South Print area of the plant is no longer needed and should be discontinued. Only those employees entering beyond the yellow marking placed around each machine should be required to wear respiratory protection.

2. Medical

The group of 57 employees examined was exclusively made up by males. Their age ranged from 31 to 60 years old. (Mean 43.5 and Median 44). Their employment length at Columbus Coated Fabrics ranged from 10 to 41 years (Mean 20.3 and Median 21). Their length of work at the Print Department ranged from 1 to 41 years (Mean 12.8 and Median 12). There were 15 employees (26.3%) who worked less than 4 years in the Print Department, indicating that they were not in the Print Department in 1973 at the time of neuropathy outbreak. However, review of their job history indicated that they had exposures to solvents in varying degrees and some were indeed affected by MBK. Therefore, same questions were asked to this subgroup of workers.

Each subject was asked whether or not he was diagnosed as having peripheral neuropathy during the 1973 survey. He was then asked what his symptoms were (numbness, weakness, etc.) and what parts of the body were affected. For each symptom, the subject was asked whether or not it has improved, stayed the same, or worsened during the past four years. He was also asked whether or not any new nerve problem has developed since the 1973 outbreak. The plant medical record of the participants was reviewed including EMG reports. On the basis of the results of this interview and review of the medical records which are summarized in Table III the group can be classified into five categories.

Category I: Of the 57 employees studied, there were 31 (54.4%) who were symptom-free and had normal EMG in 1973 and still symptom-free in 1977. This group of workers is judged as not having a peripheral neuropathy.

Category II: There were 18 (31.6%) employees who had symptoms of peripheral neuropathy, diagnosed as such in 1973 and are still having symptoms in 1977. In this group, eight stated that their symptoms have improved, nine stated no change and one stated that his symptoms have become worse. Since workers

in this category had contracted peripheral neuropathy in 1973, it is considered that they are not experiencing any new peripheral neuropathy. Where periodic EMGs were available, their trend indicated that the conditions were either stationary or showing improvement.

In the case of one person who stated that his symptoms worsened, his symptoms are "numbness of arms and legs" which he feels "going to sleep" and "diminished feeling" and "bones hurt more". His EMG in 1973 was interpreted as "minimal peripheral neuropathy"; 1974 - "minimally normal" and 1976 - "normal but patient continues to have symptoms suggesting some chronic residue".

Category III: This is the group who in 1973 had symptoms compatible with peripheral neuropathy but no EMG abnormalities, and still has symptoms in 1977. There were six men in this group, of which five said that their symptoms were more or less the same compared to four years ago, and one said that his symptoms were worse now. In this latter case, his symptoms are limited to numbness of fingers and pain in the back of both hands. His recent EMG was interpreted as "traumatic, right". This case is not considered as being a new peripheral neuropathy, although the cause for the pain in the back of both hands has not been well studied.

Category IV: There was one person who was found to have an "abnormal" EMG in 1973, but has not complained of any symptoms either in 1973 or since then.

Category V: There was one person who had neither symptoms nor EMG abnormalities in 1973 but is now complaining of numbness, tingling and weakness in the lower extremities. His EMG's were "normal" in 1973 and March 1976. However, in September 1976, it was interpreted as "sensory latency borderline, but normal motor component". The most recent EMG in March 1977 was interpreted as "normal", however, there was a comment that appropriate muscles were not selected. This case needs to be further studied to establish the nature and extent of his ailment.

F. Conclusion (Environmental/Medical)

It is believed, based on the environmental and medical data, that exposure of employees in the Print Department to MBK, MEK and MIBK did not present a hazard under conditions existing at the time of this survey and that the majority of the workers in the Print Department are either free from any symptoms suggestive of peripheral neuropathy, or are experiencing the residues of nerve damage they had in 1973. This is in agreement with the finding of a recent environmental study that there was no appreciable exposure to methyl butyl ketone in the Print Department.

There was only one case (Category V) who was apparently normal in 1973 but is now complaining of peripheral nerve symptoms. His EMG findings have not been definitive. At this point, it is difficult to determine if his condition is occupationally caused. Further medical evaluation is needed in this case.

With the above case in mind, it can be concluded that there is no new outbreak of peripheral neuropathy in the group studied.

V. RECOMMENDATIONS

The following recommendations are offered to help insure a continuing safe and healthful work environment.

1. Continue, on a regular basis, to monitor the environment around each print machine to insure levels of organic vapors do not exceed the standard.
2. Continue to improve the ventilation system.
3. Discontinue the practice of issuing respirators to anyone entering the plant.
4. The employer should continue the present program of offering EMG examination to follow-up employees who were affected by methyl butyl ketone in 1973. The employees should take advantage of it and receive EMG at least on an annual basis.
5. Employees who have noticed new or aggravation of nerve symptoms should be encouraged to report to the Company Medical Department, which upon such report, should arrange for a neurological examination of such employee.
6. NIOSH medical officer is of the opinion that there is no need at this time to conduct an all out EMG examination of Print Department employees.

VI. REFERENCES

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2. Summary Status Report of an Investigation of an Incident of Toxic Polyneuropathy at the Borden Chemical Company, Columbus Coated Fabrics Division, Columbus, Ohio. NIOSH, Nov. 1, 1973.
3. F. Patty: Industrial Hygiene and Toxicology. Vol II, 2nd Ed. Interscience Publishers, New York 1965.
4. E. Browning: Toxicity of Industrial Organic Solvents. Chemical Publishing, New York 1953.
5. Threshold Limit Values for Chemical Substances in Workroom Air by ACGIH for 1976. American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, Ohio 45201.
6. U.S. Department of Labor. Occupational Safety and Health Administration, OSHA Safety and Health Standards (Federal Register, 29 CFR 1910, pp 507, January 1, 1976).

7. Billmeier, D., Et. Al.: Peripheral Neuropathy in a Coated Fabrics Plant, J. Occup. Med. 16:665, 1974.

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Table I
Results of Personal Air Samples

Columbus Coated Fabrics
Columbus, Ohio

April 6-7, 1977

| Job Title | Location | Sample No | Sample Time | Concentration | | |
|----------------------|----------------|-----------|-------------|---------------------------|------------------------------|-------------------------------|
| | | | | MBK ppm/M ³ | MEK ppm-mg/M ³ | MIBK ppm-mg/M ³ |
| Print Color Operator | Color Mix Room | 1 | 0630-1012 | <0.01 | 26-72 | 2-8 |
| " | " | 2 | 0630-1014 | " | 32-95 | 3-12 |
| " | " | 3 | 0632-1010 | " | 53-157 | 8-34 |
| " | " | 4 | 0635-1010 | " | 85-251 | 7-31 |
| Pan Washer | South Print | 6 | 0700-1044 | " | 43-126 | 4-16 |
| Print Operator | Press H-38 | 7 | 0702-1040 | " | 26-77 | 3-12 |
| Service Helper | Floater | 8 | 0702-1033 | " | 10-30 | 2-8 |
| Print Operator | Press H-39 | 10 | 0704-1048 | " | 14-42 | 1-4 |
| Printer Helper | Press H-34 | 11 | 0705-1052 | " | 27-81 | 1-4 |
| Service Helper | Floater | 12 | 0705-1051 | " | 33-96 | 2-8 |
| Print Operator | Press H-36 | 14 | 0706-1052 | " | 24-70 | 5-19 |
| Printer Helper | " | 15 | 0707-1054 | " | 74-218 | 9-37 |
| Service Helper | Floater | 16 | 0708-1053 | " | 12-35 | 2-8 |
| Printer Helper | Press H-40 | 17 | 0708-1050 | " | 14-42 | 1-4 |
| Print Operator | " | 18 | 0709-1033 | " | 19-57 | 2-8 |
| Print Operator | Press H-37 | 19 | 0710-1030 | " | 29-86 | 6-23 |
| Printer Helper | Press H-40 | 20 | 0709-1034 | " | 18-54 | 1-4 |
| Printer Helper | Press H-38 | 22 | 0711-1042 | " | 18-54 | 2-8 |
| Print Operator | Press H-34 | 23 | 0712-1053 | " | 39-116 | 2-8 |
| Print Operator | Press H-40 | 24 | 0712-1052 | " | 4-12 | - |
| Service Helper | Floater | 25 | 0910-1428 | " | 11-33 | 2-8 |
| Print Color Operator | Color Mix Room | 26 | 1012-1343 | " | 18-54 | 1-4 |
| " | " | 27 | 1014-1345 | " | 34-108 | 3-12 |
| " | " | 28 | 1010-1344 | " | 76-224 | 3-12 |
| " | " | 29 | 1011-1344 | " | 42-122 | 3-12 |
| Pan Washer | Pan Room | 31 | 1045-1428 | " | 55-163 | 3-12 |
| Print Operator | Press H-38 | 32 | 1041-1427 | " | 35-102 | 6-24 |
| Service Helper | Floater | 33 | 1034-1427 | " | 5-14 | 1-4 |
| Print Operator | Press H-39 | 35 | 1049-1434 | " | 42-123 | 4-15 |
| Printer Helper | Press H-34 | 36 | 1052-1428 | " | 36-106 | - |
| Service Helper | Floater | 37 | 1052-1428 | " | 25-72 | 2-8 |
| Printer Helper | Press H-40 | 38 | 1052-1428 | " | 59-173 | 3-12 |
| Print Operator | Press H-36 | 39 | 1052-1428 | " | 19-55 | 2-8 |
| Printer Helper | Press H-36 | 40 | 1055-1428 | " | 33-97 | 4-15 |
| Service Helper | Floater | 41 | 1054-1428 | " | 16-48 | 2-8 |
| Printer Helper | Press H-40 | 42 | 1051-1431 | " | 14-41 | 1-4 |
| Print Operator | " | 43 | 1034-1430 | " | 7-20 | 1-4 |
| Print Operator | Press H-37 | 44 | 1031-1432 | " | 35-103 | 8-35 |
| Printer Helper | Press H-40 | 45 | 1035-1429 | " | 4-12 | 0-27 |
| Print Operator | Press H-39 | 46 | 1047-1433 | " | 16-46 | 2-8 |
| Printer Helper | Press H-38 | 47 | 1043-1447 | " | 32-93 | 4-16 |
| Print Operator | Press H-34 | 48 | 1054-1428 | " | 29-86 | 2-8 |
| Print Operator | Press H-40 | 49 | 1052-1438 | " | 2-7 | - |

Table I (cont)

Results of Personal Air Samples

Columbus Coated Fabrics
Columbus, Ohio

April 6-7, 1977

| Job Title | Location | Sample No | Sample Time | Concentration | | |
|----------------------|----------------|-----------|-------------|--------------------------|------------------------------|-------------------------------|
| | | | | MBK mq/M ³ | MEK ppm-mg/M ³ | MIBK ppm-mg/M ³ |
| Print Color Operator | Color Mix Room | 52 | 0725-1045 | <0.01 | 39-115 | 3-12 |
| " | " | 53 | 0725-1110 | " | 32-94 | 2-8 |
| " | " | 54 | 0725-1115 | " | 78-230 | 7-30 |
| Service Helper | Floater | 56 | 0700-1042 | " | 13-38 | 2-8 |
| Print Operator | Press H-39 | 57 | 0750-1436 | " | 67-197 | 26-108 |
| Print Operator | Press H-37 | 58 | 0701-1047 | " | 81-238 | 10-43 |
| Printer Helper | Press H-37 | 59 | 0702-1051 | " | 96-283 | 16-65 |
| Service Helper | Floater | 60 | 0702-1106 | " | 37-108 | 2-8 |
| Service Helper | " | 61 | 0703-1053 | " | 20-59 | 2-8 |
| Print Operator | Press H-36 | 62 | 0703-1037 | " | 25-73 | 4-16 |
| Printer Helper | Press H-40 | 63 | 0703-1034 | " | 8-24 | 1-4 |
| Service Helper | Floater | 64 | 0704-1105 | " | 14-42 | 2-8 |
| Printer Helper | Press H-35 | 65 | 0704-1048 | " | 46-136 | 4-18 |
| Printer Helper | Press H-38 | 66 | 0704-1044 | " | 43-126 | 16-68 |
| Printer Helper | Press H-36 | 67 | 0705-1041 | " | 44-131 | 7-30 |
| Service Helper | Floater | 68 | 0706-1045 | " | 46-136 | 7-30 |
| Service Helper | Floater | 69 | 0712-1036 | " | 20-58 | 2-8 |
| Print Operator | Press H-40 | 70 | 0713-1041 | " | 36-108 | 7-30 |
| Print Operator | Press H-39 | 71 | 0713-1033 | " | 27-80 | 2-8 |
| Printer Helper | Press H-34 | 72 | 0714-1057 | " | 33-98 | 3-12 |
| Printer Helper | Press H-40 | 73 | 0715-1052 | " | 16-48 | 1-4 |
| Print Operator | Press H-40 | 74 | 0920-1444 | " | 5-16 | -2 |
| Print Operator | Press H-34 | 75 | 0718-1055 | " | 17-50 | 1-4 |
| Service Helper | Floater | 81 | 1042-1430 | " | 20-59 | 3-12 |
| Print Operator | Press H-37 | 83 | 1047-1435 | " | 118-347 | 20-85 |
| Printer Helper | Press H-37 | 84 | 1051-1445 | " | 132-388 | 24-99 |
| Service Helper | Floater | 85 | 1106-1431 | " | 32-94 | 3-12 |
| Service Helper | Floater | 86 | 1053-1435 | " | 32-94 | 4-16 |
| Print Operator | Press H-36 | 87 | 1037-1447 | " | 36-105 | 5-19 |
| Printer Helper | Press H-40 | 88 | 1034-1430 | " | 12-34 | 1-4 |
| Service Helper | Floater | 89 | 1105-1431 | " | 12-34 | 3-12 |
| Printer Helper | Press H-35 | 90 | 1048-1437 | " | 31-92 | 4-16 |
| Printer Helper | Press H-38 | 91 | 1044-1435 | " | 33-97 | 18-77 |
| Printer Helper | Press H-36 | 92 | 1041-1447 | " | 57-169 | 9-38 |
| Service Helper | Floater | 93 | 1045-1431 | " | 28-82 | 6-24 |
| Service Helper | Floater | 94 | 1036-1440 | " | 25-74 | 3-12 |
| Print Operator | Press H-40 | 95 | 1041-1431 | " | 34-99 | 2-8 |
| Print Operator | Press H-39 | 96 | 1033-1437 | " | 21-61 | 3-12 |
| Printer Helper | Press H-34 | 97 | 1057-1430 | " | 32-94 | 4-16 |
| Printer Helper | Press H-40 | 98 | 1052-1438 | " | 42-125 | 1-4 |
| Print Operator | Press H-34 | 100 | 1055-1433 | " | 30-87 | 2-8 |

Table II
 Results of Area Air Samples
 Columbus Coated Fabrics
 Columbus, Ohio
 April 6-7, 1977

| <u>Sample</u> | <u>Location</u> | <u>Sample No</u> | <u>Sample Time</u> | <u>Concentration</u> | | |
|---------------|--------------------|------------------|--------------------|---------------------------------|-------------------------------------|--------------------------------------|
| | | | | <u>MBK</u> mg/M ³ | <u>MEK</u> ppm-mg/M ³ | <u>MIBK</u> ppm-mg/M ³ |
| General Area | Operator Desk H-38 | CCF A-1 | 1215-1405 | <0.01 | 32-94 | 8-34 |
| " " | " " H-37 | A-2 | 1217-1405 | " | 48-140 | 15-61 |
| " " | " " H-36 | A-3 | 1218-1406 | " | 43-127 | 3-12 |
| " " | " " H-35 | A-4 | 1219-1407 | " | 14-41 | 2-8 |
| " " | " " H-34 | A-5 | 1415-1512 | " | 29-85 | 6-24 |
| " " | Nip Area-38 | A-8 | 1420-1515 | " | 304-895 | 84-350 |
| " " | Rest Area H-36 | A-9 | 1422-1514 | " | 3-8 | 1-4 |

Table III

Results of Questionnaire Survey
Columbus Coated Fabrics
Columbus, Ohio
June 23, 1977

A. Make-up of those surveyed

| | | | |
|-------------------------|--------------|-------------|---------------|
| 1. Sex: all male | | | |
| | <u>Range</u> | <u>Mean</u> | <u>Median</u> |
| 2. Age of employees | 31-60 | 43.5 | 44 |
| 3. Years at C.C.F. | 10-41 | 20.3 | 21 |
| 4. Years at Print Dept. | 1-41 | 12.8 | 12 |

B. Comparison of Peripheral Neuropathy Symptoms

| Year: | 1973 | | 1977 | | Total | % |
|-------|----------------------|--------------------------|----------------------|--|-------|------|
| | Symptoms (Yes-No) | Abnormal EMG (Yes-No) | Symptoms (Yes-No) | Present Condition (Better, Same, Worse) | | |
| I. | No | No | No | | 31 | 54.4 |
| II. | Yes | Yes | Yes | Better = 8 Same = 9 Worse = 1* | 18 | 31.6 |
| III. | Yes | No | Yes | Better = 0 Same = 5 Worse = 1* | 6 | 10.6 |
| IV. | No | Yes | No | | 1 | 1.7 |
| V. | No | No | Yes | | 1* | 1.7 |

TOTAL = 57 100.0

* See text for explanation