

SURVEY OF PREMIUM FINISHES, INCORPORATED

PB81-230674



Cincinnati, Ohio

DATE OF SURVEY:

October 17, 24-25 and November 13-December 11, 1973

SURVEY CONDUCTED BY:

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Joseph S. Mallov, M.D.
Philip J. Bierbaum
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DATE OF REPORT:

August 1974

**Division of Field Studies and Clinical Investigations
National Institute for Occupational Safety and Health
Cincinnati, Ohio**

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16. Abstract (Limit: 200 words) Worker exposures to methyl-butyl-ketone (591786) (MBK), methyl-isobutyl-ketone (108101) (MIBK), methyl-ethyl-ketone (78933) (MEK), xylene (1330207), toluene (108883), butanol (71363), isopropanol (67630), diacetone-alcohol (123422), and methylene-chloride (75092) were surveyed on October 17, 24, and 25, and November 13 to December 11, 1973, at Premium Finishes, Inc. (SIC-2851) in Cincinnati, Ohio. The incidence of peripheral neuropathy among the 18 employees also was investigated. General area, personal air, and bulk samples were analyzed. Workers completed health questionnaires and underwent neurologic examinations. MBK exposures to the roller mill operator exceeded the OSHA standard of 410 milligrams per cubic meter (mg/cu m), and mixed vapor exposures exceeded the 1.0mg/cu m standard. All samples for MIBK, MEK, xylene, toluene, butanol, isopropanol, diacetone-alcohol, and methylene-chloride were below OSHA standards of 410, 590, 435, 750, 300, 980, 240, and 1750mg/cu m, respectively. Bulk samples did not contain detectable amounts of tri-ortho-cresyl phosphate (78308) or acrylamides. Neurological abnormalities in two workers were possibly related to MBK exposure. Local exhaust fans were undersized and did not provide adequate air circulation. The authors conclude that a potential hazard exists due to organic vapor exposure, and that MBK exposure may be related to subclinical neurologic disease. They recommend implementation of medical surveillance and industrial hygiene programs, improvement of exhaust ventilation, use of protective gloves and moisture creams for the skin, and isolation of eating areas.				
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PLACE VISITED

Premium Finishes, Incorporated
10448 Chester Road
Cincinnati, Ohio 45215
Telephone: 513/771-6870

DATE OF WALK-THROUGH SURVEY:

October 17, 1973

**DATE OF FOLLOW-UP INDUSTRIAL
HYGIENE SURVEY:**

October 24-25, 1973

DATE OF MEDICAL SURVEY:

November 13-December 11, 1973

PERSONS PARTICIPATING IN SURVEY:

Troy Marceleno, P.E.
Philip J. Bierbaum
Joseph S. Mallov, M.D.
Ralph D. Zumwalde
Paul L. Johnson

PERSONS CONTACTED:

Premium Finishes, Incorporated

Ronald Savin, President
William A. Renz, Executive V.P.

State of Ohio, Division of Occupational
Health

Dorothy G. Benning, R.N.

PURPOSE:

To conduct an environmental and medical survey of a facility that uses methyl butyl ketone and also to take air samples and bulk samples of raw materials so as to correlate, if possible, employee exposures to diagnosis of employee peripheral neuropathy.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is conducting a study of industrial users of methyl butyl ketone (MBK) and the possibility of peripheral neuropathy developing in workers exposed to the solvent. This investigation was initiated in September 1973 because of diagnosis of such neuropathies in employees of a coated fabric facility. The initial indications were that MBK, which was used as part of a solvent formulation in various operations of the coated fabric facility, was the possible agent causing the affliction. An industrywide medical and environmental study, was, therefore, begun in an attempt to confirm or disprove the theory.

On October 17, 1973, NIOSH and the Ohio Department of Health personnel conducted a walk-through survey at Premium Finishes, Incorporated (PFI), Cincinnati, Ohio, a producer of paints and a large user of MBK. This survey was necessary because of the known exposure of plant personnel to MBK over a four-year period. Survey objectives consisted of (1) identifying present and past work practices concerning the usage of MBK; (2) securing plant history and production data; (3) taking preliminary air samples and bulk samples of raw materials; and (4) determining the need for detailed environmental and medical data for possible correlation of worker exposure levels to medical abnormalities.

Present at the October 17, 1973 meeting and participating in the walk-through survey later that day were Philip J. Bierbaum, Troy Marceleno, and Joseph S. Mallov, M.D., Division of Field Studies and Clinical Investigations, NIOSH. Mrs. Dorothy G. Benning represented the Ohio

Department of Health. In addition to securing plant history and production data, a total of nine area and personal samples were collected.

On October 24 and 25, 1973, a detailed industrial hygiene survey was conducted. This was followed by medical studies of production employees from November 13 to December 11, 1973.

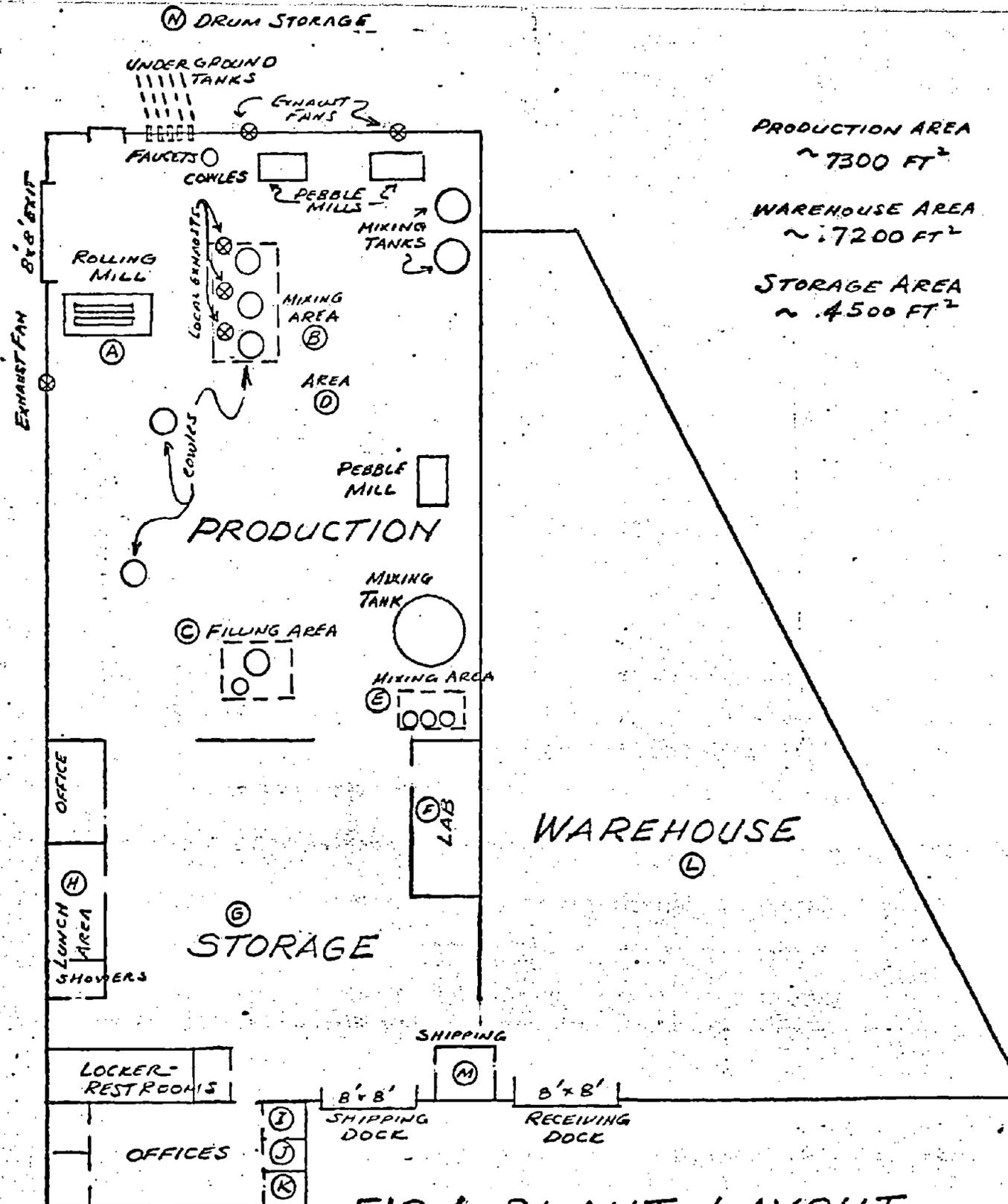
The follow-up, detailed industrial hygiene survey consisted of collecting a total of 118 personal and area samples, and four bulk samples for evaluation of MBK airborne levels and contamination in the raw materials that possibly could cause peripheral neuropathy. This survey was conducted by Troy Marceleno, Ralph D. Zumwalde, and Paul L. Johnson, Division of Field Studies and Clinical Investigations.

The medical investigation was conducted by Dr. Joseph Mallov and Drs. J. Parke Biehl and John Steiner of the University of Cincinnati Department of Neurology. It consisted of: (1) the administration of a questionnaire dealing with medical and occupational histories; (2) clinical neurological evaluations; (3) electromyography; and (4) nerve conduction velocity testing.

PLANT BACKGROUND AND DESCRIPTION

General

PFI began doing business in 1961 as the Black Diamond Paint Company. The Company was purchased by Mr. Ronald Savin in 1967 and the name changed to Premium Finishes, Incorporated. In 1969, the existing plant was expanded through the addition of 7,000 square feet of warehouse space and now totals around 21,000 square feet (see Figure 1 for a schematic diagram of the plant.).



PRODUCTION AREA
~ 7300 FT²
WAREHOUSE AREA
~ 7200 FT²
STORAGE AREA
~ 4500 FT²

FIG 1. PLANT LAYOUT

PREMIUM FINISHES, INC.
10448 CHESTER RD.
CINCINNATI, OHIO 45215

The plant operates on a 5-1/2 days per week, one shift per day schedule. As of October 25, 1973, a total of 18 persons, 11 of these production employees worked there. Plant personnel have no union affiliation at present. The Company primarily produces paints. These include vinyls, urethanes, latexes, acrylics, oil based paints, epoxys, hypalon coatings, alkyls and polyesters. Of these types, only the vinyls and polyesters contain MBK.

During the last four years, the plant's vinyl paint production has increased from an estimated 15,000 gallons in 1969 to about 160,000 gallons in 1973. Vinyls constitute about 25 percent of the total paint produced at PFI today.

Solvents usage also has increased. In 1972 and 1973, total solvent use was about 150,000 gallons. Table 1, below, shows the solvents presently used.

Medical Program

PFI has no in-house medical facilities. In the event of emergencies or illness, employees are provided for at the Chester Road Medical Center located several blocks from the facility. The Prudential Insurance Company provides compensation insurance but does not provide safety or industrial hygiene services. Employees do not receive pre-employment examinations. Until the time of the survey, no specific medical problems were evident except for one employee's alleged allergy to epoxy with resulting dermatitis.

Industrial Hygiene and Safety Program

Until September 1973 when PFI received an Occupational Safety and Health Administration (OSHA) inspection, the Company neither had, or observed, any type of formal safety or industrial hygiene program other than on-the-job direction provided by the plant foreman.

Table 1

LIST OF SOLVENTS USED

Premium Finishes, Incorporated
Cincinnati, Ohio

	<u>1972</u>	<u>1973</u>
Xylene	x	x
Toluene	x	x
VM and P (Naptha)	x	x
Mineral Spirits	x	x
HiSol 10 F (Aromatic Solvent)	x	x
Isobutyl Isobutylrate (IBIB)	x	x
Methylene chloride	x	x
Isopropal alcohol anhydrous	x	x
Diacetone alcohol	x	x
2-Nitro propane	x	x
Cellosolve acetate	x	x
Methyl Isobutyl Ketone (MIBK)	x	x
Methanol	x	x
467 Solvent (Aromatic Solvent)	x	x
Isobutanol	x	x
Methyl Butyl Ketone (MBK)	x	x
N-Butanol	x	x
Methyl Ethyl Ketone (MEK)	x	x
Acetone	x	x
DI-Methyl formamide	x	x
Methyl cellosolve	x	x
Ethyl alcohol	x	x
Etheylene glycol	x	x
D-100 solvent (same as Hi-sol 10F)	x	x
Hi sol 98F	x	
Chlorothene NU	x	
Sc solvent #100	x	
Methyl Isoamyl Ketone (MIAK)	x	
Linseed Oil	x	x

Presently, all employees are urged, but not required, to take showers after work. They are provided with three uniforms each, so that at least two work clothes changes per week are possible. They eat in a separate eating room which is outside of the production area but open and adjacent to it. Eye protection and hardhats are required. While management has urged that employees use Industrial cleaners to wash their hands, most continue using reclaimed solvents. Protective gloves, essential when cleaning drums or cowles (large vats), were not being used. Respirators, also required by management when cleaning cowles and drums with solvents, were not being used.

DESCRIPTION OF THE OPERATION

General

Liquid raw materials for paints such as thinners (mineral spirits, toluene, xylene, VMP naphtha and linseed oil) are delivered by truck and stored in underground tanks at the rear of the plant. Other solvents such as MBK, MEK, MIBK and plasticizers (Alkids) that are difficult to pump during the winter because of their viscosity are received in 55 gallon drums at the dock (see Area M, Figure 1). They are stored in the warehouse (Area L) until ready for use, along with pigments, resins and other raw materials that come packaged in 50 pound bags such as leads and lead naphthanates. Used drums are placed outside the plant (Area N) and then are taken to be reconditioned by one of three local drum firms.

Paint manufacturing at PFI is basically done as a small, batch-type operation. Consequently, a large amount of manual labor is involved. Paint

or paint products being made are put through several processes. These include:

1. Dissolving of pigment in solvent;
2. Mixing or dispersion (smoothing) of pigment;
3. Thinning or letting down;
4. Filling of containers.

Dissolving, Mixing and Dispersion

At PFI, pigments are smoothed out in one of three pebble mills (enclosed rotating drums, Areas B and D), or on the plant's roller mill (Area A), depending mostly on the viscosity of the pigment mixture. The paint pigments, plasticizers, and other additives are then dissolved in solvents, by placing and mixing them in cowles.

Pebble mills are used for thin mixes where free movement is required. They are also employed when mixing pigments for longer durations (40-48 hours) and when mixing lead-based or other paints where exposure to employees may be undesirable. After mixing, the pigment is drained out from the pebble mill through large spouts into cowles where cooling (down to 77°F), thinning (letting down) takes place.

If the roller mill is used, the pigments and resins are added to a small amount of solvent and additives such as fillers, suspension agents, etc. After being mixed in open cowles, they are handed into the roller mill. Here, the paints are exposed to the air and mixed as a heavy paste. After reaching a certain consistency, the paste automatically feeds into another open drum, is cooled and let down. Mixing in the roller mill is usually a two to five hour process. As with pebble mill mixing, it is characterized by temperature rises up to 125°-150°F.

Letting Down

This process is characterized by the lowering of mixture temperature followed by the addition of other materials that will give the paint a specified viscosity, color, evaporation rate, odor, elasticity or other characteristic. At PFI, this part of the process is done in open cowles, mostly in Area B. Color matching, viscosity and developmental measurements and quality control are made in the lab (Area F).

Filling

After letting down, the paints are poured from the cowles into 55 gallon barrels and then transferred into 5 or 10 gallon containers for shipment. This is accomplished by pouring the paint from a faucet in the barrel through an organdy drop cloth into the cans.

Typical Products

Tables 2-4 show typical formulations for major products produced at PFI. In each case, only the ingredients are shown so as to protect the proprietary nature of the information.

INSPECTION OF THE PLANT

Potential Health Hazards

The following is a list of potential health hazards noted during the survey.

- a. Skin and respiratory exposure to solvents, and other paint ingredients during mixing, testing, pouring and cleaning-up operation.
- b. Potential eye contact with solvents during mixing, pouring and cleaning up.
- c. Excessive noise in proximity of roller mill (92 dbA).

Table 2

QUICK DRY ALKID ENAMEL INGREDIENTS

Premium Finishes, Incorporated
Cincinnati, Ohio

Ingredients Mixed In Cowles

6065 Resin (Glycol--from acids and alcohols)
RE 30 Titanium Pigment (whiteness)
Sulfex Inert (filler to prevent sagging)
Alum Sterate (suspending agent).
Xylene (solvent)

Ingredients Added in Letting Down Process--In Cowles

Resin
50% Alkid (plasticizer to prevent brittleness)
Xylene (solvent)
VM and P Naptha (increases evaporation)
26% Lead Napthanene (pure lead used to dry paint throughout
Also, bottom drier)
12% Calcium (drier activator)
8% Cobalt-liquid form (top drier)
Vanilla (deodorant)
Pthalo Blue (bluing agent)

Table 3

WEATHER COTE T - WHITE VINYL INGREDIENTS

Premium Finishes, Incorporated
Cincinnati, Ohio

Ingredients Mixed in Small Cowles, Run on Roller Mill

DIDP (plasticizer)
RF 30 Titanium Dioxide (hides pigment)
VMCA-Vinyl (body)
MBK (solvent)

Ingredients Added in Letting Down Process--In Cowles, Little Mixing

VMCA-Vinyl (body)
2013 dry Aerylic (to harden paint and increase gloss--reacts
chemically with VMCA)
VERR-Vinyl (increase adhesion)
MBK (fast solvent to dissolve vinyl)
Cellosolve acetate (slower evaporating solvent to reduce paint)
D100 Solvisso (slowest solvent used in vinyls)
MBK (solvent)
IBIB (cheaper solvent to reduce cost)

Table 4

RED LEAD PRIMER INGREDIENTS

Premium Finishes, Incorporated
Cincinnati, Ohio

Ingredients Mixed in Pebble Mill

97% Red lead
NA 4284 Red oxide pigment
399 Talc (clouding agent)
Aluminum stearate (suspending agent)
AlO-Extender (adds silica body; and reduces cost)
Raw linseed oil (paint base drier)
Type 3 (445-50) Alkyd resin
Mineral spirits
Lead naphanate (drier)
Calcium (drier)
Cobolt (drier)
Anti-skin (anti-oxident)
Xylene (solvent)

Housekeeping

The plant appeared to be in need of a general cleanup, especially in the thinner storage area at the rear of the plant; the production area where paint spills were evident; and in the warehouse, where the floor was covered with powdery spills from the paper bags containing pigments, lead naphthanates and other paint ingredients. Aisles in the warehouse and elsewhere had not been marked although cited during the September 26, 1973 OSHA inspection. The lunch room, lockers and shower areas were littered and dusty. The yard area behind the plant was especially messy, being covered with used barrels awaiting cleaning.

The area at the rear of the plant that houses thinner faucets (thinners are stored underground) was especially messy and could pose a fire problem. The paint storage area between the office and paint production area was neat and orderly but seemed to be overloaded, and limited direct passage out of the production area in case of an emergency.

Work Practices

It was noted that plant employees were not using the industrial hand cleaners provided by management but relied instead on reclaimed solvents for cleaning up. Gloves were not evident nor were respirators. The shower facilities, in general, were not being used as shown by the debris in the shower stalls.

Ventilation

The ventilation system at PFI consisted of small local exhausts situated near the cowles in the mixing area (Area B); however, during the surveys, they were inoperable. Otherwise, the plant relies on three window mounted exhaust fans located in the production area and whatever air movement can be generated

from the front loading dock doors to an eight feet by eight feet door located next to the roller mill at the rear of the plant (Area A). In Area A, where the roller mill is located, the operator works directly over the paint being mixed. Although this unit is located next to the rear door opening, the draft out of the room (50 ft./sec.) failed to reduce the strong solvents odor.

SURVEY PROCEDURES

Walk-Through Survey (October 17, 1973)

Four personal and five general area samples were collected for worker exposures to organic vapors. These air samples were collected at one liter per minute for ten minutes on activated charcoal (MSA Organic Vapor Sampling Tubes). The samples were taken primarily in the production area (Areas A, B and D) where prior measurements taken with a Century Organic Vapor Analyzer (Model OVA-98A) indicated high gas concentrations (170-2000 ppm). One man employed primarily in Area A (roller mill operator) but whose responsibilities also took him to other plant areas wore the personal samplers for an estimate of breathing zone exposures.

The charcoal tubes were analyzed for MBK, xylene, MIBK, MEK, butanol, isopropanol, diacetone alcohol and methylene chloride using a gas chromatographic method similar to that described by White, et. al.¹ The results of these analyses are shown in Table 5.

Detailed Industrial Hygiene Survey (October 24-25, 1973)

A total of 118 general area and personal air samples were collected (using the same technique as mentioned above), together with four bulk samples of solvents used in the plant. At least five area samples were collected from

Table 5

ORGANIC SOLVENT CONCENTRATIONS*
Premium Finishes Incorporated
Cincinnati, Ohio
October 17, 1973

Sampling Description And Area	Sample Number	Solvent Concentrations (mg/m ³)									
		MBK 410*	Xylene 435**	Toluene 750**	MIBK 410**	MEK 590**	Butanol 300**	Isopro- panol 980**	Diace- tone Al. 240**	Methy. Chlor. 1750**	Mixture Exposure 1.00***
Personal Samples (Roller Mill Op.)											
B	16	70	44	86	11	15	<2	<4	<6	17	0.45
B & A	19	137	56	117	32	25	<2	<4	<6	<4	0.74
A	22	1389	30	59	104	11	<2	16	<6	<4	3.83
A	20	1636	43	101	119	9	<2	4	<6	<4	4.53
General Area Samples											
D	18	29	57	194	15	124	<2	<4	<6	91	
B	12	240	19	98	29	2	<2	<4	<6	73	
B	13	234	48	121	38	46	<2	<4	<6	20	
A	14	222	15	38	18	<2	<2	<4	<6	<4	
A	17	97	13	55	4	<2	<2	<4	<6	<4	

* Reflect 10-minute samples

** Occupational Safety and Health Administration daily time-weighted average standards,

*** OSHA multiple organic vapor exposure standard,

each plant area in random fashion during the day for each of the two days sampled. This was achieved by dividing the eight-hour working day into 48-10 minute sampling periods and then referring to a random numbers distribution table to select five periods² to be sampled. The charcoal samples thus collected were analyzed for MBK, xylene, toluene, MIBK, methanol, MEK, n-butanol, isopropanol, diacetone alcohol and methylene chloride as described previously, and the average of the five results for each area calculated. These are shown in Table 6.

Personal samples were collected on the charcoal tubes with Sipin low flow pumps at a sampling rate of approximately 50 cc per minute. This rate allowed sampling over a longer period of time (3-4 hours). The samples were analyzed for the same solvents as were the area samples. These results are shown in Table 7.

Ventilation

Ventilation measurements were taken at the three exhaust fans located on the north and east sides of the buildings, at the spray booth in the laboratory, and at the 8' x 8' rear door using an Anor Loflo meter. These results are shown in Table 8.

Table 6. GENERAL AREA ORGANIC SOLVENT CONCENTRATIONS*

Premium Finishes, Inc.
Cincinnati, Ohio
October 24-25, 1973

Sampling Area	Sample No.	SOLVENT CONCENTRATIONS (mg/m ³)								
		Dichloro-Methane 1740**	MEK 590	Isopropanol 980	Toluene 750	Xylene 435	MIBK 410	MBK 410	n-Butyl Alcohol 300	Diacetone Alcohol 240
J	101	<11	<10	<10	<13	<11	<10	<14	<10	<10
H	102	<10	<10	<10	<7	<15	<12	<58	<10	<10
K	103	<10	<10	<10	<7	<8	<10	<12	<10	<10
I	104	<10	<10	<10	7	<9	<10	<13	<10	<10
L	105	<20	<12	<11	13	10	<12	<24	<10	<10
A	106	<10	<10	<10	16	17	<14	95	<10	<10
C	107	<10	<13	<41	<20	<13	<9	<75	<10	<10
D	108	<10	<11	<10	<33	<18	<12	<17	<10	<10
B	109	<10	<14	<10	44	38	<26	94	<10	<10
G	110	<10	<10	<10	<8	<7	<9	<12	<10	<10
A	P 1	<23	<11	<12	40	22	19	<21	<10	<10
J	P 2	<10	<10	<10	12	12	<10	<10	<10	<10
L	P 3	<21	<10	<10	<10	<6	<10	<10	<10	<10
D	P 4	<15	<10	<10	14	13	<16	<12	<10	<10
K	P 5	<10	<10	<10	13	11	<11	<10	<10	<10
C	P 6	<18	<20	<13	46	19	<25	<25	<10	<10
H	P 7	<10	<10	<10	<5	<5	<10	<10	<10	<10
B	P 8	<10	<10	<14	<29	13	<14	<18	<10	<10
E	P 9	<16	<13	<10	20	11	<13	<10	<10	<10
F	P 10	<10	<10	<10	<7	<8	<18	<10	<10	<10

* Average concentrations from five random period, 10 minute samples

** OSHA daily time weighted average standards

Table 7. PERSONAL ORGANIC SOLVENT CONCENTRATIONS*

Premium Finishes, Inc.
Cincinnati, Ohio
October 24-25, 1973

Sampling Area	Sample No.	SOLVENT CONCENTRATIONS (mg/m ³)									Mixture Value
		Dichloro Methane 1740 **	MEK 590	Isopropanol 980	Toluene 750	Xylene 435	MIBK 410	MBK 410	n-Butyl Alcohol 300	Diacetone Alcohol 240	
B	1	<2	<2	<2	3	8	<2	6	<2	<2	.04
B	2	<2	16	<2	28	1	17	84	<2	<2	.31
	3	<13	<13	<13	28	16	43	58	<13	<13	.32
F	4	<3	7	9	109	1	23	195	<3	<3	.70
C	5	60	59	12	78	1	40	142	<2	<2	.70
A	7	40	11	7	26	28	52	309	<7	<7	1.02
C	8	<2	<2	<2	1	1	<2	<2	<2	<2	.003
C	9	100	119	16	121	35	57	38	<3	<3	.75
C	10	<2	2	19	19	17	10	52	<2	<2	.22
A	11	<8	14	68	54	23	73	665	8	<8	2.04
	12	<8	15	<8	27	5	92	14	<8	<8	.33
D	14	<29	<29	<29	2	2	<29	<29	<29	<29	.006
A	15	<6	<6	<6	86	43	22	40	<6	<6	.36
C	16	124	147	14	162	18	20	17	<8	<8	.68
M	17	4	<4	<4	3	2	<4	<4	<4	<4	.01
	19										
A	20	16	7	5	51	24	27	15	5	5	.28
C	21	193	222	25	279	57	148	18	<7	<7	.39

* 3-4 hour samples

*** OSHA multiple organic vapor exposure standard.

** OSHA daily time weighted average standards

Table 8

VENTILATION MEASUREMENTS
- Premium Finishes, Incorporated
Cincinnati, Ohio
October 24, 1973

<u>Location</u>	<u>Flow Reading, fpm</u>
Spray booth laboratory	115
Exhaust fans, mixing room	50
Rear door, mixing room	50

Medical

All current production employees (eight men), as well as two male control subjects (volunteers from NIOSH) were medically examined at the University of Cincinnati Medical Center utilizing electromyography (EMG), nerve conduction velocity testing, and a questionnaire dealing with medical and occupational history. The questionnaire was designed to elicit information concerning the duration and extent of exposure to MBK, neuromuscular symptomatology, and possible other causes for peripheral nerve damage in each patient (alcoholism, diabetes, drugs such as Isoniazid, herniated discs, etc.).

The EMG and nerve conduction velocity tests were conducted by Dr. J. Parke Biehl of the University of Cincinnati Department of Neurology, without prior knowledge of the medical or occupational history of the subjects. He was informed that some would have had exposures to a possible neurotoxin but was not informed which of the subjects fell into this category and which were controls. Limb or skin temperatures were not taken. Motor conduction velocity was measured in the right peroneal and median nerves using standard techniques (which in fact measure the velocity over the fastest conducting fibres in each nerve); sensory conduction velocities were not measured. Motor velocity was measured in the right median nerve segment extending from the elbow to the wrist, and in the right peroneal nerve segment extending from the knee to the ankle.

EMG's were performed in each of the following muscles: (1) right upper limb - first dorsal interosseous, abductor pollicis brevis, abductor digiti quinti, extensor digitorum communis, and flexor carpi ulnaris; (2) right lower

limb - tibialis anterior, gastrocnemius, soleus, flexor hallucis longus, first dorsal interosseous, abductor digiti quinti, and abductor hallucis. The following parameters were looked for: positive sharp waves, fibrillation, fasciculation, other potentials (at rest), potentials on minimum effort (wave form and amplitude), potentials on maximum effort (quantity of motor units), and the degree of polyphasic potentials.

A clinical neurological evaluation was performed by another member of the Department of Neurology, Dr. John Steiner. Dr. Steiner was aware that his patients had been exposed to a possible neurotoxin, but was not aware of the results of the EMG and nerve conduction velocity tests on each patient. The control subjects were not sent for clinical evaluation and there was one production employee who did not receive a clinical evaluation; the latter had worked only two weeks at the plant and had symptoms antedating his employment by many months.

Blood was drawn from each production employee for SMA, prothrombin time, two hour post-prandial blood sugar and blood lead level. A urine specimen was obtained for mercury determination. The lead and mercury measurements were performed by Kettering Laboratory, Cincinnati, Ohio. The other lab tests were run by a commercial clinical laboratory. Lead and a minimal amount of mercury were the only neurotoxic heavy metals used at the plant as determined by the environmental survey. There was no use of arsenic, antimony, or thallium at the plant. Tables 9-14 show the results of the medical investigations.

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Cincinnati, Ohio

TABLE 9

EMG AND NERVE CONDUCTION VELOCITIES

	Controls	Premium Finishes Employees
A) Normal	2 (cases 1 and 2)	3 (cases 5, 6, and 7)
B) Abnormal, with a ready explanation from extra-occupational causes.	0	3 (cases 8, 9, and 10)
C) Abnormal, without a ready explanation from extra-occupational causes.	0	2 (cases 3 and 4)

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TABLE 10

CLINICAL HISTORIES

	Controls	Premium Finishes Employees
<u>Do not suggest peripheral neuropathy</u>	<u>2</u>	<u>5</u>
A) EMG and nerve conduction velocities normal	2 (cases 1 and 2)	1 (case 5)
B) EMG and/or nerve conduction velocities abnormal, but with an obvious extra- occupational explanation	0	2 (case 9 and 10)
C) EMG and/or nerve conduction velocities abnormal, without an obvious extra-occupational explanation	0	2 (cases 3 and 4)
<u>Suggest peripheral neuropathy (bilateral, distal symptoms in 1973)</u>	<u>0</u>	<u>3</u>
A) EMG and nerve conduction velocities normal	0	2 (cases 6 and 7)
B) EMG and/or nerve conduction velocities abnormal, but with an obvious extra-occupational explanation	0	1 (case 8)
C) EMG and/or nerve conduction velocities abnormal, without an obvious extra-occupational explanation	0	0

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TABLE 11

NEUROLOGICAL EXAMINATIONS

	Controls	Premium Finishes Employ
<u>Do not suggest peripheral neuropathy</u>	-	<u>7</u>
A) EMG and nerve conduction velocities normal	-	3 (cases 5,6, and 7)
B) EMG and/or nerve conduction velocities abnormal, but with an obvious extra-occupational explanation	-	2 (cases 8 and 9)
C) EMG and/or nerve conduction velocities abnormal, without an obvious extra-occupational explanation	-	2 (cases 3 and 4)
<u>Suggest peripheral neuropathy</u>	-	<u>0</u>
A) EMG and nerve conduction velocities normal	-	0
B) EMG and/or nerve conduction velocities abnormal, but with an obvious extra-occupational explanation	-	0
C) EMG and/or nerve conduction velocities abnormal, without an obvious extra-occupational explanation	-	0

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TABLE 12

AGE OF PRODUCTION WORKERS WITHOUT APPARENT
NON-OCCUPATIONAL CAUSE FOR NEUROPATHY

	Age
With EMG and/or nerve conduction velocity abnormalities	46 Yrs, 25 Yrs.
Without EMG and/or nerve conduction Velocity abnormalities	40 Yrs., 30 Yrs., 24 Yrs.

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TABLE 13

ALCOHOL CONSUMPTION AMONG PRODUCTION WORKERS
WITHOUT APPARENT NON-OCCUPATIONAL CAUSE FOR NEUROPATHY

(See Key Below)

With EMG and/or nerve conduction
abnormalities

Very Light, Medium

Without EMG and/or nerve conduction
abnormalities

Very Light, Medium, Heavy

Very Light Drinker =

- 0-1 can of beer/day for 0-10 years
and/or
- 0-1/4 bottles of wine/week for 0-10 years
and/or
- 0-1 other drinks/week for 0-10 years

Light Drinker =

- 1-3 cans of beer/day for 0-10 years
or
- 0-1 cans of beer/day for > 10 years
or
- 1/4 - 1/2 bottle wine/week for 0-10 years
or
- 0-1/4 bottle wine/week for > 10 years
and/or
- 2-4 other drinks/week for 0-10 years
or
- 0-1 other drinks/week for > 10 years

Medium Drinker =

- 4-9 cans beer/day for 0-10 years
or
- 1-3 cans beer/day for > 10 years
and/or
- 1/2-1 bottle of wine/week for 0-10 years
or
- 1/4-1/2 bottles of wine/week for > 10 years

Table 13
Continued

and/or
4-8 other drinks/week for 0-10 years
or
2-4 other drinks/week for > 10 years

Heavy Drinker =

> 9 cans beer/day for 0-10 years
or
≥ 4 cans beer/day for > 10 years
and/or
≥ 1 bottle of wine/week for 0-10 years
or
≥ 1/2 bottle of wine/week for >10 years
and/or
≥ 8 other drinks/week for 0-10 years
or
≥ 4 other drinks/week for >10 years

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Cincinnati, Ohio

TABLE 14

WORK HISTORIES OF PRODUCTION WORKERS WITHOUT
OBVIOUS NON-OCCUPATIONAL CAUSE FOR NEUROPATHY

	With EMG and/or nerve conduction velocity abnormalities	Without EMG and nerve conduction velocity abnormali- ties
<u>Duration of Employment</u>	3 Yrs., 11 Yrs.	8 Mos.; 3 Yrs., 17
<u>Present Job</u>	1. Roller Mill- grinds paint (Case 4) 2. Paint Maker- cowles dissolver (Case 3)	1. Assistant Fore (Case 5) 2. Fill off - hoi (Case 7) 3. Lab Technician small roller m (Case 6)
<u>Number of Skin Contacts/ Hour with Thinner</u>	1, 3	1, 4, "Continuous"
<u>Daily Change of Work Clothes?</u>	No, No	No, No, No
<u>Number of Cigarettes Per Work Shift</u>	6, 10	6, 10, 10
<u>Wears Gloves</u>	Yes, Yes	No, No, No
<u>Washes with Soap Before Eating</u>	Yes, Yes	No, No, Yes
<u>Shower after Work</u>	Home, Immediately; Home, Delayed	Home, Delayed; Home, Delayed; Home, Delayed

Table 14 Continued

Wears Apron

No, No

No, No, No

Clothing Change After Work

At Plant; At Plant

At Plant; At Plant;
At Plant

Uses Solvents from Plant

At Home

Yes, No

Yes, No, No

DISCUSSION OF RESULTS

Environmental

Organic Vapors - As was indicated earlier, Table 5 shows personal and general area vapor concentrations as determined on October 17, 1973. Tables 6 (area samples) and 7 (personal samples) show the results from the October 24-25 detailed industrial hygiene survey. The personal sampling results can be compared to the OSHA time-weighted average (TWA) standards, including those for multiple organic vapor exposures (mixture exposure). As can be seen from samples 20 and 22 in Table 5, the OSHA standard for MBK was exceeded in the roller mill operation. The roller mill operator works directly over the paint (and solvents) without the benefit of any local exhaust ventilation, thus the high MBK readings.

The results in Tables 6 and 7 are quite low by comparison with those found in Table 5. This was because those in Table 5 were taken in the afternoon when air vapor concentrations were at a maximum while those in Tables 6 and 7 reflect an eight-hour average. Another reason for the low readings was because of the pleasant weather occurring on October 24-25 which caused the employees to open the doors to the front dock and rear door of the plant. Even so, in Table 7, the OSHA TWA standards were exceeded four times--once for MBK in Area A (Sample 11) and three times for multiple organic vapor exposures in areas A and C (Samples 7, 11 and 21). From data in Tables 5, 6, 7 and 8, it appears that area A, where the roller mill operation is located, contains the greatest exposure risk to MBK for employees at PFI. This is verified by the personal samples collected from the roller mill operator who is assigned to work primarily in that area. The raw data from which Tables 6 and 7 were compiled also showed a tendency toward higher vapor

concentration in the early morning, most likely as a result of leaving uncovered overnight, cowlings of paint which had not been completed or from which paint was being transferred to smaller containers. The vapor concentrations appeared to subside during the mid-morning after the front dock and rear doors were opened but gradually built up by mid-afternoon as solvents use and paint production increased. It is expected that during the winter months, when doors and windows in the plant are kept shut to conserve heat, that the solvent levels will be much higher and will exceed the OSHA TWA standards to a higher degree.

Bulk Samples

The four bulk solvent samples were analyzed qualitatively by gas chromatography for tri-ortho cresyl phosphate (TOCP) and acrylamides. No TOCP or acrylamides were detected at the 0.06 mg TOCP/ml or 20 µg/ml acrylamide level in any of the pure solvents.

Ventilation

The measurements taken during the October 17, 24 - 25 surveys are shown in Table 8. The capture velocity of the spray booth located in the lab (Area F) was found to meet the 100-200 fpm. capture velocity recommendation for spray booths in which dispersion of contaminants is made into air of low velocities. This confirmed the findings during the September 26, 1973 OSHA inspection.

The window exhaust fans on the other hand were found to be grossly undersized. At the present time, the exhaust fans are estimated to change

the air in the production area only once per day. The large 8 ft. x 8 ft. door at the rear of the plant helps out considerably. The air velocity through it was measured at 50 feet per minute (with front dock door open). This would allow a change of air in the mixing room every 40 minutes. Taken together, they fall far short of the recommended ten air change per hour (once every six minutes under normal plant conditions)³.

Medical

As is shown in Table 9, five out of a total of eight production workers at PFI had abnormalities on either EMG or nerve conduction velocity testing or both; however, three of the five had an obvious non-occupational explanation for the abnormalities. This leaves two men (Cases #3 and #4) without an obvious extra-occupational explanation for the electrophysiological abnormalities. One possible variable that could have accounted for the abnormalities in these two men is limb temperature; cold limbs can account for a decrease in nerve conduction velocity and an increase in the percentage of polyphasic wave forms present in the absence of real disease^{4,5,6}. On after-the-fact questioning, Case #3 (with a peroneal nerve conduction velocity of 34.2 meters/sec.) did say that his legs were cold at the time that the EMG was taken. Case #1, a control who had an EMG taken on the same afternoon as Case #3, corroborated a history of a cold examination room, and said that he, too, had cold legs that day. On the other hand, (1) Case #1 did not have an abnormal EMG; (2) both Cases #3 and #4 had a substantially decreased number of motor unit action potentials in at least four muscles on maximum effort, an abnormality not known to be related to temperature; and (3) the percentage of polyphasics in cases #3 and #4 was probably more than can be accounted for by temperature alone. As

regards the last point, according to Buchthal⁷, even at an intramuscular temperature of 25-29°C, only 30-45 percent of all potentials recorded are polyphasic.

From Table 10, no correlation was found between clinical history and electrophysiologic findings. Neither cases #3 nor #4 had a history suggesting peripheral neuropathy. Furthermore, two of the other three men with abnormal EMG's gave no history of any symptoms in the lower extremities. On the other hand, two cases out of three with a clinical history which could suggest neuropathy had normal EMG's and nerve conduction velocities.

In Table 11, none of the seven cases clinically examined had findings suggesting peripheral neuropathy on neurological exam. The eighth case, with an extremely abnormal EMG not related to occupation, did not show up for a clinical exam.

From Tables 12 and 13, no obvious differences were noted in age or alcohol intake between Cases #3 and #4, on the one hand, and Cases #5, #6, and #7 on the other. (Cases #5, #6, and #7 having no electrophysiologic abnormalities.) There were differences in work history, however, as can be seen in Table 14.

Current jobs were different and Cases #3 and #4 may well have had more exposure to MBK than did the others. This is suggested by Table 7, which gives personal sampler solvent concentrations reflecting three or four hour samples taken on October 24 and 25, 1973. Samples 11 and 7, corresponding to Case #4, clearly yielded the highest concentrations of MBK in the plant (665 and 309 mg/M³), and sample 11 also yielded the highest multiple organic vapor value (2.04). Sample 4, corresponding to Case #3, yielded the second

highest concentration of MBK in the plant (195 mg/M³), although the multiple organic vapor value was not inordinately high. The only other personal sample giving concentrations of MBK above 100 mg/M³ was sample 5 (142 mg/M³) corresponding to Case #10. (Case #10 had extensive EMG abnormalities not attributed to occupation.) (Sample 5 also yielded the second highest multiple organic vapor value.)

It may be argued that Case #4 had four personal samples measured (7, 11, 15 and 20), whereas Cases #5, #6 and #7 had only one each; however, if the personal samples from Case #4 are averaged, the average (257 mg/M³) still is higher than any personal sample reflecting the other job types.

The data from the area samples (Table 6) do not reveal a clear difference between the MBK concentration of Area A (where case #4 worked; 95 mg/M³) and Area B (where Cases #5, #6 and #8 worked; 94 mg/M³ and 18 mg/M³); however, it is felt that personal samples are a much better method of monitoring the concentrations at the actual breathing zone than are area samples.

It should also be noted that Table 5, which reflects 10 minute samples taken on October 17, confirmed a very high level of personal exposure to MBK for Case #4 (levels of 1389 mg/M³ and 1636 mg/M³ while operating the roller mill, corresponding to personal Samples A). Unfortunately, no personal samples from Case #3 were taken on that day.

Cases #3 and #4 had more careful work habits than Cases #5, #6, and #7 taken as a group; i.e., Cases #3 and #4 both wore gloves on the job and washed with soap before eating. This may well have been because their jobs entailed more exposure to paint and solvents than the jobs of the others.

CONCLUSIONS AND RECOMMENDATIONS

Environmental

On the basis of the walk-through survey and the follow-up industrial hygiene survey, it appears that there is a potential danger to PFI employees from continued exposure to organic vapors in excess of OSHA standards. This is based on the fact that TWA's were exceeded in October, when weather conditions permitted the opening of plant doors to increase ventilation, reducing by a substantive amount, the expected higher concentrations which no doubt occur during the winter when plant doors must be kept closed. These conditions are compounded by poor industrial hygiene practices of some plant employees (washing hands in solvents, failure to wear gloves and respirators, or failure to shower after each day's operation). The above, when taken together with the inadequate plant ventilation system (inoperable local exhausts and undersized wall fans) can lead to no other conclusion.

Medical

Because of the small sample size, the lack of temperature control, an inadequate number of control subjects, and the lack of correlation between electrophysiological studies and clinical histories or physical exams, one cannot say anything definitive about the incidence of peripheral neuropathy in the plant population. Yet, for the reasons cited earlier, it would be difficult to attribute all the electrophysiologic abnormalities in Cases #3 and #4 to low temperature. One cannot ignore the possibility that the EMG and nerve conduction velocities may detect subclinical disease before there are any symptoms or physical signs. This seemed to be the situation at the previously mentioned coated fabric facility during their outbreak of peripheral

neuropathy⁸. While the rough correlation cited earlier between electrophysiological abnormalities and MBK levels at PFI may be coincidental, it would also be compatible with the hypothesis of subclinical disease related to MBK.

Recommendations

The recommendations below are intended to resolve the problems noted at PFI from an environmental and medical point of view.

1. The Company should, as soon as possible, initiate a periodic medical surveillance program for present employees, with special emphasis on skin, respiratory, neurological and hearing problems because of the potential for exposures to solvents, powdery resins and noise.

2. Employees who were examined by Drs. Mallov, Steiner and Biehl and perhaps other employees who have had exposures to MBK, should undergo further physical and neurological examinations. These findings should be reported to the National Institute for Occupational Safety and Health for further input into the industrywide study on this occupational health problem.

3. Based on the total organic vapor levels found in and near Areas A and C, there is a potential for exposure in other plant areas to organic vapors in excess of OSHA standards during the winter when vapors from these areas drift to other plant areas and concentrate above OSHA time-weighted average levels.

4. The plant management should conduct an industrial hygiene survey to further document the results presented here (especially when the building is completely closed during the winter); and where appropriate,

Institute further control measures and work practices to reduce the high vapor concentrations. In the interim, those employees who are able, from a health standpoint, should be required to wear respirators. All others should be removed from the area of excess levels until the control is instituted. This survey should include evaluation of the entire plant but especially the roller mill and filling areas. Where found necessary, upgrading of environmental conditions by means of engineering changes should be undertaken. Some items that could be considered at PFI include:

a. Exhaust ventilation for the roller mill operation to draw the solvents horizontally away from the operator.

b. Exhaust ventilation for the filling area to draw the air away from the workers who are filling the containers.

c. Exhaust ventilation for the cowles in the mixing area.

5. As indicated earlier, skin contact with solvents was noted as problem at PFI. This should be minimized by:

a. Enforcing a requirement for wearing gloves. This should also include the requirement for long sleeve shirts and/or arm length gloves;

b. Not allowing hand cleaning, etc., with solvents. Provisions should be made to supply employees with an appropriate industrial cleanser that is soluble in water and can remove the varnishes, stains and lacquers without harming the skin. Moisture creams also should be supplied for application after the cleansers.

6. It is recommended that the eating area be further removed from the production area. Otherwise, it should be enclosed and provided with proper ventilation to prevent concentration of solvent vapors there.

7. Plant management is also urged to provide all workers with pre-employment physicals to establish baseline data and permit ready detection of subsequent physical changes.

