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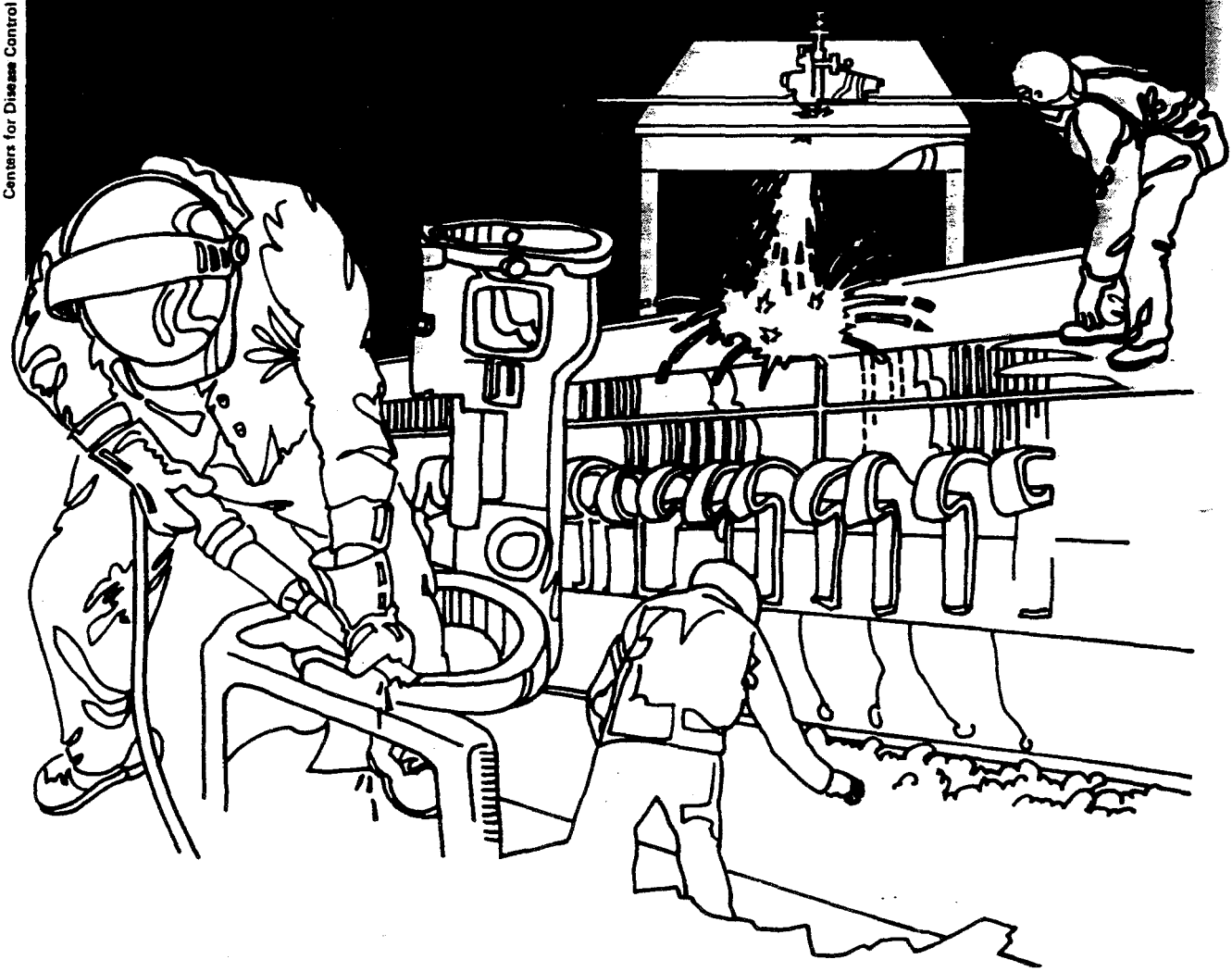

Health Hazard Evaluation Report

HETA 83-184-1416
PENN EMBLEM COMPANY
PHILADELPHIA, PENNSYLVANIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 83-184-1416
February 1984
PENN EMBLEM COMPANY
PHILADELPHIA, PENNSYLVANIA

NIOSH INVESTIGATOR:
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I. Summary

On March 21, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation to determine the employees' exposures at the screen printing and ink blending operations to xylene, other solvents and dust at the Penn Emblem Company, Philadelphia, Pennsylvania.

An initial visit was made to Penn Emblem Company on April 13, 1983. Environmental surveys were conducted on April 19-20, 1983 for cellosolve, cellosolve acetate, xylenes, methylene chloride and toluene-2,4-diisocyanate (TDI). Due to sampling problems for methylene chloride, repeat samples were taken on August 31, 1983.

Personal and area air samples were collected at the silk screen printing operations, ink blending and screen cleaning operations for cellosolve, cellosolve acetate, xylenes and TDI. Operator's exposure at the screen printing operation for cellosolve ranged from 4.90-9.14 ppm (per million parts of air), for cellosolve acetate 2.20-7.57 ppm and xylenes 1.22-5.18 ppm. Operator's exposure at ink blending to cellosolve ranged from 3.84-6.95 ppm, to cellosolve acetate 9.05-15.2 ppm and to xylenes 3.88 to 12.9 ppm. Operator's exposures at the screen cleaning operation ranged from 13.4-19.4 ppm for cellosolve, 2.05-3.70 ppm for cellosolve acetate and 1.34-2.30 ppm for xylenes. All air samples collected for TDI were below the limit of detection which was 0.3 microgram per sample.

The respective Occupational Safety and Health Administration (OSHA), NIOSH and American Conference of Governmental Industrial Hygienists (ACGIH) criteria for cellosolve are: 200 ppm, Lowest Extent Possible (LEP) and 50 ppm. For cellosolve acetate; 100, LEP and 500 ppm and for xylenes all state 100 ppm. ACGIH has proposed a standard of 5 ppm for both cellosolve and cellosolve acetate.

Since the solvent in the ink is a mixture, a formula had to be used to determine the Threshold Limit Value (TLV) where the concentration and time of exposure were considered. Samples for the individual components and mixture formulas did not exceed OSHA standards.

Ten of the 15 air samples collected for cellosolve and six of the 15 air samples collected for cellosolve acetate exceeded the proposed ACGIH of 5 ppm. All 15 samples exceed the proposed ACGIH and NIOSH TLV for mixtures 1.09-4.19. Limit is unity [1].

On August 31, 1983, 20 air samples were collected for methylene chloride at the screen repair, blending and screen washing operations. The following are the criteria for this substance: OSHA - 500 ppm, NIOSH - 75 ppm and ACGIH - 100 ppm. Employees' exposures did not exceed these criteria at the blending (15 ppm TWA) and cleaning (16 ppm TWA) operations. However, the NIOSH and ACGIH time-weighted average (TWA) was exceeded at the screen repairing station (154 ppm TWA).

NIOSH has determined that under the present criteria there are no excessive exposures to cellosolve, cellosolve acetate and xylene mixture solvent. When the proposed ACGIH criteria for cellosolve and cellosolve acetate are utilized, individual component and combined solvent exposure criteria are exceeded. Exposure to methylene chloride exceeded the ACGIH and NIOSH criteria at the screen repair station. Recommendations have been incorporated in this report for controlling exposure to the solvents.

KEYWORDS: SIC 3999 (Miscellaneous manufactured products, decals and logos), cellosolve, cellosolve acetate, xylene, methylene chloride, chest pains/congestion, nose bleeds, headaches, menstrual problems.

II. Introduction

On March 21, 1983, a request was submitted by Local 837, Teamsters Union expressng concern that the press operators and ink blenders are not feeling well as a result of exposure to xylene and other solvents.

III. Background

On April 13, 1983, the NIOSH Regional Industrial Hygienist met with representatives of the company and the employees for the opening and closing conferences and walk-through survey. On April 19-20, 1983, environmental air sampling and the administration of non-directed medical questionnaires were completed to gather data regarding the adverse health effects the employees were experiencing. An interim report was sent to plant management and the representative of the employees in July 1983. It included recommendations for protective clothing, housekeeping and ventilation.

On August 31, 1983, additional environmental air sampling was conducted.

Penn Emblem Company designs and manufactures emblems, name badges and logos for uniforms. At the request of the customer, a design is composed. This is transferred to silk screens. Each screen contains one phase of the final emblem. Using successive silk screen printings and various colored inks, the final emblem or logo is produced. There is a drying period following each printing. After drying the sheets are die cut and packaged.

Solvents are used as diluents for the inks, screen and plate cleaning and screen washing. At the screen repair operation, methylene chloride is used to soften the hardened ink so that it can be scraped off.

Penn Emblem Company performs their own periodic atmospheric air evaluations. Air samples collected are analyzed by an independent laboratory.

IV. Environmental Design

a) Cellosolve, Cellosolve Acetate, Xylenes

Fourteen personal air samples were collected at the silk screen printing, ink blending and screen washing operations on April 19-20 and August 31, 1983. These samples were collected on charcoal tubes and with sampling pumps operating at approximately 150 cubic centimeters (cc) per minute. The A & B sections of the charcoal tubes were analyzed using NIOSH Method P&CAM 127[1] with modifications. The limit of detection for these analytes was 0.01 milligram per sample (mg/s).

Two of the above personal air samples taken at the screen cleaning operation were additionally analyzed for methylene chloride. Analyses of these samples showed that greater than 30 percent of the methylene chloride was on the B section of the charcoal tube. This necessitated a reevaluation for this contaminant.

b) Methylene Chloride

Twenty personal air samples were collected for methylene chloride on August 31, 1983 at the ink blending, screen washing and screen repair operations. These samples were collected on charcoal tubes with sampling pumps operating at 50 cc per minute. The sample size was approximately 2.25 liters. These samples were analyzed by gas chromotography using NIOSH Method S-329 (1) with modifications. The limit of detection was 0.01 mg/s.

c) 2,4-Toluene Diisocyanate (Diisocyanate)

A material safety data sheet supplied by the manufacturer stated that the ink contained 0.7% based on resin solids of 2,4-toluene diisocyanate. Nine personal air samples were collected at the ink mixing and screen printing operations on glass wool tubes and were analyzed by modifications of NIOSH Method P&CAM 326(1). The limit of detection was 0.3 microgram per sample.

d) Silica

There was some concern about a thickening agent used in the ink blending area. A bulk sample of the material was submitted for analysis. This sample was analyzed for quartz and cristobalite by NIOSH Method P&CAM 259. The lower limit of quantitation was 0.03 milligram based on a 2-milligram portion for both polymorphs of silica. Both polymorphs were below this value.

e) Carbon monoxide

On August 31, 1983, several area samples during the sampling period were taken with Draeger short-term indicator tubes and hand-held bellows pump for carbon monoxide. (In the presence of carbon monoxide, an indicating layer in the tubes discolors from white to brownish-green, and the length of the discoloration corresponds to the carbon monoxide concentration in parts per million.)

V. Evaluation Criteria

A. Environmental Criteria

As a guide to the evaluation of the hazard posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if: their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical conditions, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure.

Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Govermental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8 to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA exposures.

The criteria for the solvents are contained in Tables 3 and 4.

B. Solvents

The solvents used in the paint and ink industry are usually a mixture of hydrocarbons. A suitable hydrocarbon thinner should function somewhat as follows. It should have the power to dissolve the vehicle, i.e., to unpack it and disperse it uniformly, and to maintain solution or dispersion, during storage at room temperatures to be encountered. It should reduce viscosity as efficiently as possible, while fulfulling the necessary requirements as to solvency and volatility. It must evaporate from the freshly laid-down film in such a fashion that a uniform coating, of maximum overall adhesion, is deposited on the surface. The hydrocarbons found in the ink were cellosolve, cellosolve acetate and xylenes. The hydrocarbon used for cleaning and repair was methylene chloride.

1. Cellosolve and Cellosolve Acetate [2] - Cellosolve is readily hydrolyzed in the body to 2-ethoxyethanol (ethylene glycol monoethyl ether) a glycol ether. The National Institute for Occupational Safety and Health (NIOSH) recommends that glycol ethers be regarded in the workplace as having the potential to cause adverse reproductive effects in male and female workers. These recommendations are based on the results of several recent studies that have demonstrated dose-related embryotoxicity and other reproductive effects in several species of animals exposed by different routes of administration. Of particular concern are those studies in which exposure of pregnant animals to concentrations of glycol ethers at or below their respective Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL's) led to increased incidences of embryonic death, teratogenesis, or growth retardation. Exposure of male animals resulted in testicular atrophy and sterility. In each case, the animals had been exposed to glycol ethers at concentrations at or below their respective Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL's). Therefore, appropriate controls should be instituted to minimize worker exposure to both compounds.

2. Xylenes (3) - Xylene vapor may cause irritation of the eyes, nose, and throat. Repeated or prolonged skin contact with xylene may cause drying and defatting of the skin which may lead to dermatitis. Liquid xylene is irritating to the eyes and mucous membranes, and aspiration of few milliliters may cause chemical pneumonitis, pulmonary edema, and hemorrahage. Repeated exposure of the eyes to high concentrations of xylene vapor may cause reversible eye damage.

Acute exposure to xylene vapor may cause central nervous system depression and minor reversible effects upon liver and kidneys. At high concentrations xylene vapor may cause dizziness, staggering, drowsiness, and unconsciousness. Also at very high concentrations. breathing xylene vapors may cause pulmonary edema, anorexia, nausea, vomiting, and abdominal pain.

3. Methylene Chloride (4,5) - Repeated contact with methylene chloride may cause a dry, scaly, fissured dermatitis. The liquid and vapor are irritating to the eyes and upper respiratory tract at higher concentrations. If the liquid is held in contact with the skin, it may cause skin burns.

Methylene chloride is a mild narcotic. Effects from intoxication include: headache, giddiness, stuper, irritability, numbness, and tingling in the limbs. Irritation to the eyes and upper respiratory passages occurs at the higher dosages. In severe cases, observers have noted toxic encephalopathy with hallucinations, pulmonary edema, coma, and death. Cardiac arrythmias have been produced in animals but have not been common in human experiences. Exposure to this agent may cause elevated carboxyhemoglobin levels which may be significant in smokers or workers with anemia or heat disease, and those exposed to carbon monoxide.

VI. Results and Discussion

Fourteen personal environmental air samples were collected for cellosolve, cellosolve acetate and xylenes at the screen printing, ink blending and screen washing operations.

a) Cellosolve - Exposure to cellosolve ranged from 2.55 to 19.4 ppm. There was one sample that showed an exposure of 68.3 ppm. This value was unexpectedly high. Nine of the environmental air samples exceeded the proposed ACGIH criteria. (Table 1)

b) - Cellosolve Acetate - Exposures to cellosolve acetate ranged from 2.05 to 15.2 ppm. Five of the environmental air samples exceeded the proposed ACGIH criteria. (Table 1)

c) Xylenes - Xylene exposures ranged from 1.22 to 12.9 ppm. All employee exposures were well below the accepted criteria. (Table 1)

d) Methylene Chloride - On April 19 and 20, 1983, two atmospheric air samples collected at the screen washing operation were analyzed for methylene chloride. Concentrations found were 17.1 and 29.6 ppm, respectively. Work was intermittent at the screen repair station and this operation could not be evaluated. Due to the fact that 30% of the methylene chloride was found on part B of the charcoal tube, all operations where methylene chloride may have been present, viz., ink blending, screen cleaning and screen repair, were reevaluated on August 31, 1983. Samples collected were for approximately 45 minutes and maximum air volume of 2.5 liter. The employee exposures to methylene chloride ranged from 15 ppm at the ink mixing and screen cleaning operation to 154 ppm at the screen repair operations. Exposure at the screen repair operation exceeded the NIOSH and ACGIH criteria and approached (483 ppm) the ACGIH short-term exposure limit of 500 ppm for 15 minutes. (Table 2)

e) 2,4-Toluene Diisocyanate - Atmospheric air evaluations were done for 2,4-toluene diisocyanate. Nine personal samples were collected and analyzed. All samples were none detected.

f) Additive Effects/Combined Exposures - The results of atomspheric air samples which contained cellosolve, cellosolve acetate and xylenes were inserted into the formula (Table 3) to determine if the additive effects exceeded unity (1). Except for one sample, where the amounts of cellosolve found was questionable the formula did not exceed unity using the present OSHA and ACGIH criteria. Utilizing the criteria of 5 ppm proposed by ACGIH and used by some manufacturers of cellosolve and cellosolve acetate, all atmospheric air samples exceeded unity.

g) Discussion - Following the initial visit of April 19-20, 1983 during which a minimal amount of screen repairing was done and exposures to methylene chloride could not be evaluated, a back draft air exhaust ventilation system was installed on the screen repair table. This unit appears adequate; however, certain operational procedures should be corrected. It was noted that the employee does not utilize the exhaust ventilation, but places a five gallon pail on the floor and performs the old screen removal and application of the methylene chloride and old ink scraping outside the air exhaust ventilation zone.

The present gloves used by the employee, a neoprene coated type, give poor protection to methylene chloride. Most manufacturers recommend a polyvinyl alcohol type of glove for this type of operation. Since three of the four organic solvents used can be absorbed through the skin, an evaluation of all protective clothing should be performed to determine their permeability.

From the results obtained from the 14 non directed medical questionnaires the following major complaints were reported by ten employees; headaches - 7; respiratory 4; nose bleed - 3: menstrual irregularities - 3; and dizziness, chest pains, eye problems - 2 each.

VII. Recommendations

1) Investigate the possibility of replacement of the solvents now used with less toxic solvents and those which will not be absorbed through the skin.

2) Install adequate ventilation in the ink mixing room. At the present time, a small fan is in place on the wall near the ceiling. This exhaust ventilation is inadequate and necessitates the use of NIOSH-approved respirator for organic vapors. Relocation of the fan to a lower location where the organic vapors are generated will prevent unnecessary exposure.

3) Set up a maintenance program for all local exhaust ventilation systems to assure they are operating at maximum capacity.

4) Until such a time as safer solvents are used, evaluate the permeability of all the protective clothing.

5) The non-approved respirator used in the screen cleaning department should be replaced with a NIOSH-approved respirator for protection against organic vapors. At the present time, there is no cartridge respirator approved for methylene chloride. NIOSH recommends that a supplied-air respirator should be used.

6) Maintain respirators in a sanitary manner. Respirators, when not in use, should be stored in sanitary containers.

7) Any solvents that are spilled on the skin should be immediately washed with soap and water. Clothing on which solvent may have been splashed should be removed.

8) Inform the operator at the screen repair station of the toxic effects of methylene chloride. Instruct him in the proper procedures to be followed in screen removal and application of methylene chloride to soften the ink.

VII. Authorship and Acknowledgments

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IX. Distribution and Availability of Report

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS).

X. References

1) NIOSH, Manual of Analytical Methods, Vol. 1, (NIOSH) Publication #77-157A, 1977: Vol 3, (NIOSH Publication #77-157C, 1977; Vol. 5, #79-141, 1979; Vol. 6, #80 125, 1980.

2) NIOSH Current Intelligence Bulletin 39, Glycol Ethers, NIOSH Publication #83 112, Ma 1983.

3) NIOSH, Criteria for a Recommended Standard, Occupational Exposure to Xylene, Publication #75-168, 1975.

4) NIOSH, Criteria for a Recommended Standard, Occupatioanal Exposure to Methylene Chloride, Publication #76-138, March 1976.

5) Occupational Diseases: A Guide to Their Recognition, USPHS, CDC, NIOSH Publicaiton #77-181, Revised June, 1977.

Table 1

Penn Emblem Company
Philadelphia, Pennsylvania

HHE 83 184

Results of Personal Air Sampling for Organic Vapors*

Operation	Sampling Period	Cellosolve	Cellosolve Acetate	Total Xylenes	Methylene Chloride	Levels for Mixtures** OSHA	ACGIH	ACGIH***
			4/19/83					
#4 Press	07:18-15:03	4.90	2.20	1.66	--	0.06	0.16	1.44
#3 Press	07:15-15:05	68.3 ****	2.21	1.22	--	0.37	1.42	14.1
#2 Press	07:10-15:07	7.37	4.27	2.70	--	0.11	0.27	2.35
Blender	07:05-14:55	5.38	10.2	3.88	--	0.17	0.35	3.16
Cleaner	07:10-15:10	13.4	2.05	1.34	17.1 *****	0.13	0.49	3.26
			4/20/83					
Cleaner	07.55-15:10	16.7	2.32	1.65	29.63*****	0.18	0.70	4.12
#1 Eagle Press	07:20-15:13	9.14	7.57	5.18	--	0.18	0.39	3.39
Coater	07:50-15:20	2.55	5.14	1.92	--	0.08	0.17	1.09
Blender	07:45-11:30	3.84	9.05	12.9	--	0.24	0.39	2.71
			8/31/83					
Cleaner	05:43-08:00	13.6	3.04	2.10	--	0.13	0.43	4.12
	08:00-12:30	19.4	3.70	2.30				
Blender	05:30-07:47	4.57	15.2	10.5		0.28	0.52	4.19
	07:47-12:20	6.95	13.8	10.6				
#3 Press (General Air)	07:50-12:23	6.80	3.86	2.63		0.10	0.25	2.16

* Denotes parts per million parts of air sampled.
** Denotes that if the sum of the following fractions: $\frac{C^1}{T^1}+\frac{C^2}{T^2}+\frac{Cn}{Tn}$ exceeds unity, then the acceptable level of the mixture should be considered as being exceeded.
C^1=observed atmospheric concentration
T^1=threshold limit

*** Proposed
****This value appears very high compared with other samples. Source of discrepancy cannot be explained.
*****Concentrations may have been higher. Greater than 30% found on B section of tube.

TABLE 2

Penn Emblem Company
Philadelphia, Pennsylvania

HHE 82 184

Results of Sampling for Methylene Chloride

Operations: Ink Blender

Sample #	Time	Concentration*	
3	05:30-06:14	8	
4	06:14-06:57	17	
7	06:57-07:47	19	TWA** 16
10	07:47-08:35	21	
13	08:35-09:15	50	
18	09:15-09:35 10:05-10:31	52	

Operation: Screen Cleaner

1	05:43-06:26	26	
5	06:26-07:08	25	
8	07:08-07:55	17	
11	08:00-08:48	23	TWA 16
14	08:48-09:30	33	
17	10:45-11:35	21	
20	11:35-12:20	20	

Operation: Screen Repair

2	05:45-06:29	221	
6	06:29-07:15	69	
9	07:15-08:00	483	TWA 153
12	08:00-08:47	194	
15	09:48-09:25	324	
16	10:25-11:10	279	
19	11:10-12:00	107	

* Denotes - parts of contaminant per million parts of air sampled.
** Denotes - 8-hour Time-Weighted Average.

TABLE 3

Penn Emblem Company
Philadelphia, Pennsylvania

HHE 83 184

Exposure Standards*

	OSHA	ACGIH	ACGIH (Proposed	NIOSH
Cellosolve **	200	50	5	LEP***
Cellosolve Acetate **	100	50	5	LEP
Xylenes	100	100	100	100
Methylene Chloride	500	100	75	75**

* Denotes - part per million parts of air.
** Denotes - potential contribution to overall exposure by the cutaneous route including the mucous membrane and skin.
*** Denotes - lowest extent possible.

In order to determine if there were overexposures to mixtures of organic solvents, the following formula was used:

$$E_m + \left[\frac{C_1}{L_1} + \frac{C_2}{L_2}\right] + \ldots \left[\frac{C_n}{L_n}\right]$$

where E_m is the equivalent exposure for the mixture C_1 is the observed atmospheric concentration and L_1 is the corresponding threshold limit value. If the sum of the fractions exceeds unity (1), then the threshold limit of the mixture should be considered as being exceeded. The formula is only used when the chief effects are in fact addictive, which they were in this case.

TABLE 4

Penn Emblem Company
Philadelphia, Pennsylvania

HHE 83 184

CRITERIA FOR METHYLENE CHLORIDE

OSHA	NIOSH	ACGIH
500	75	100
1000 Ceiling	500 Ceiling	500 (For no more
2000 (5-min. in any 2-hrs.)	(average over 15-min. period)	than a total of 30-min. during a workday)

NIOSH further states that carbon monoxide can be a factor in determing the criteria:

1) In the absence of occupational exposure to CO above a time-weighted average (TWA) of 9 ppm for up to a 10-hour workday, occupational exposure to methylene chloride shall be controlled so that workers are not exposed to methylene chloride in excess of 75 ppm (261 mg/cu m) determined as a TWA for up to a 10-hour workweek.

2) In the presence of exposure to CO in the work environment at more than 9 ppm determined as a TWA exposure for up to a 10-hour workday, exposure limits of CO, or methylene chloride or both shall be reduced to satisfy the relationship:

$$\frac{C(CO)}{L(CO)} + \frac{C(CH2Cl\ 2)}{L(CH2Cl\ 2} \leq 1$$

where:

C(CO) = TWA exposure concentration of CO, ppm
L(CO) = the recommended TWA exposure limit of CO = 35 ppm
C(CH2Cl 2) = TWA exposure concentration of methylene chloride, ppm
L(CH2C9 2) = the recommended TWA exposure limit of methylene chloride = 75 ppm

3) Occupational exposure shall be controlled so that workers are not exposed to methylene chloride above a peak concentration of 500 ppm (1,740 mg/cu m) as determined by any 15-minute sampling period.

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