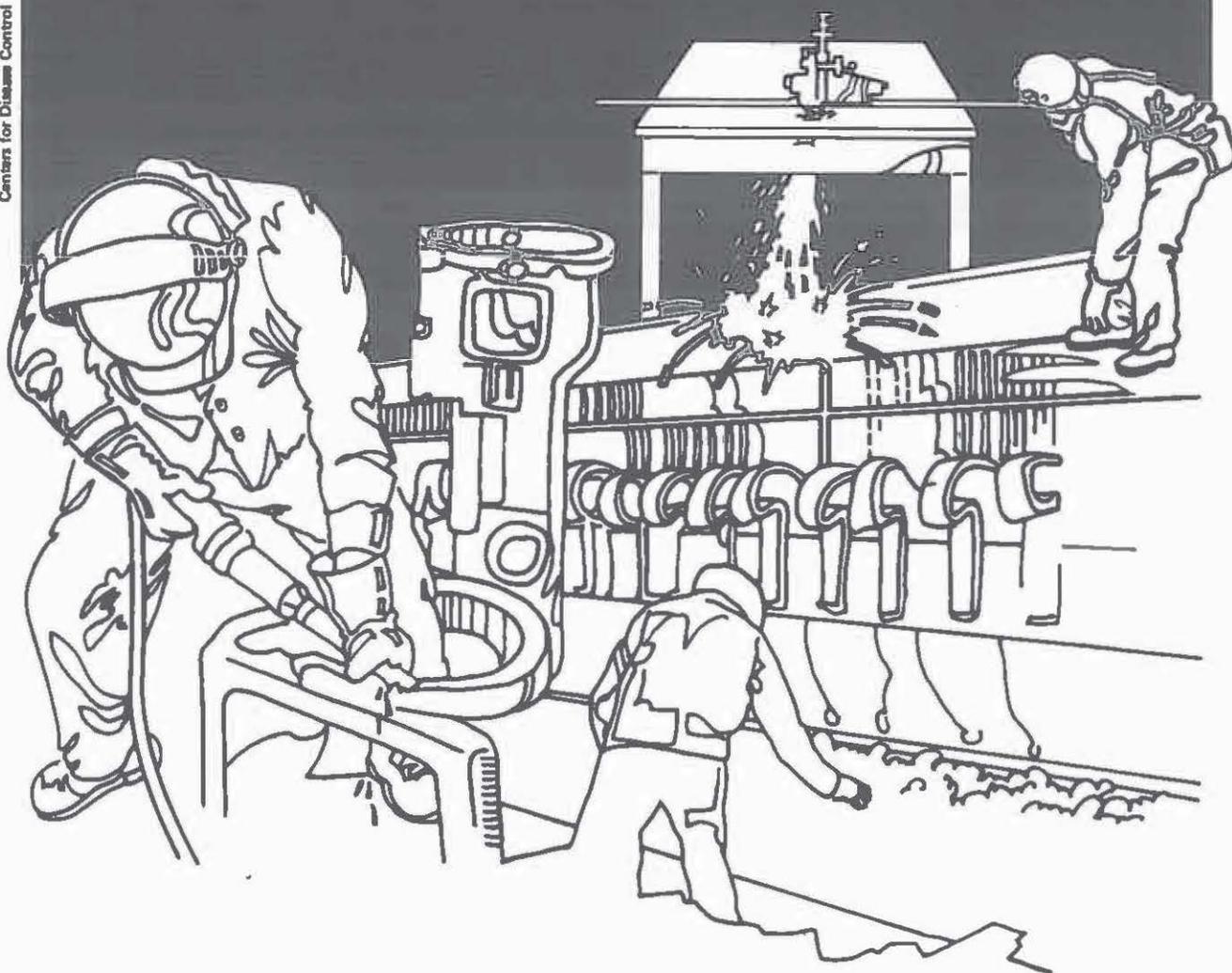


# NIOSH



## Health Hazard Evaluation Report

HETA 81-289-971  
ANCHOR HOCKING CORPORATION  
CHESTER, WEST VIRGINIA

HETA 81-289-971  
October 1981  
Anchor Hocking Corporation  
Chester, West Virginia

NIOSH Investigators:  
Steven A. Lee, IH  
Jay C. Klemme, MD, MPH

## I. SUMMARY

In April 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate adverse health effects reported by a worker during screen printing at Anchor Hocking Corporation, Chester, West Virginia. At the time of the study, one worker printed dinnerware decoration decals on one semiautomated screen-printing press.

NIOSH industrial hygiene and medical representatives interviewed the printer and conducted environmental sampling of her workplace on May 12, 1981. While at work, symptoms consisted of frequent headaches, light headedness, eye tearing and redness, and throat irritation. Pronounced exhaustion and somnolence were reported in evenings after work. The severity of symptoms was considered by the worker to be directly related to the use of a specific lacquer product.

Personal breathing zone samples for organic vapors were collected on activated charcoal through battery-powered sampling pumps operating at 50 cc/min. Acetone, isopropanol, methyl isobutyl ketone (MIBK), toluene, xylenes, and trimethylbenzenes were quantitated by gas chromatography. The 8-hour time-weighted average (TWA) exposure to trimethylbenzene was 29 parts per million (ppm). The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) of 25 ppm. The exposure levels of each of the other contaminants were well below their individual evaluation criteria. When considering the combined health effect of all the hydrocarbon vapors, NIOSH found that the printer was exposed to levels 1.5 times the recommended limit.

NIOSH has determined that a hazard from overexposure to screen-printing contaminants, primarily trimethylbenzenes, existed during the time of the NIOSH survey.

Recommended guidelines for controlling this hazard are discussed in Section VIII of the report.

KEYWORDS: SIC 2750 (commercial printing), screen printing, silk-screening, screen printers, printing solvents, combined solvent exposures, trimethylbenzene, neurological effects, mucous membrane irritation.

## II. INTRODUCTION

In April 1981, NIOSH received a request for a health hazard evaluation from a worker at Anchor Hocking Corporation, Chester, West Virginia. She requested that NIOSH evaluate the occurrence of headaches, light headedness, dizziness, exhaustion, and burning eyes, nose, and throat, that she was experiencing during screen printing. A NIOSH industrial hygienist and an occupational physician interviewed the printer and conducted an industrial hygiene survey of the printing room on May 12, 1981.

## III. BACKGROUND

Anchor Hocking manufactures ceramic dinnerware at their Chester, West Virginia plant. Much of the dinnerware is decorated with decals which are produced on large paper sheets by the screen printing process as depicted in Figure 1.<sup>1</sup> Generally the operation consists of (1) placing the sheet of material to be printed under the frame, (2) lowering the screen-image frame onto the sheet, (3) placing ink on the screen and spreading it with a squeegee, and (4) lifting the frame, removing the sheet, and placing it on a drying rack.

One worker prints the decals on one semiautomated printing press in a room of about 4000 cubic feet. The printed sheets are placed on racks and left to dry in the work area. One day per week for six hours the printer uses a lacquer on the printing press to apply translucent pastel-colored strips over the printed decals. This specific process was reported by the worker to be associated most often with adverse health effects. No product information defining the constituents of the lacquer was available at the plant during the NIOSH survey.

## IV. EVALUATION DESIGN AND METHODS

High-volume air samples were collected during lacquer printing and during solvent cleaning of the screen and press at the end of the day. The samples were drawn on charcoal tubes at 500 cubic centimeters/minute (cc/min.) for five hours during printing and one hour during cleaning. Gas chromatography/mass spectrophotometry was used to identify organic vapors.

Personal breathing zone samples for organic vapors were collected on activated charcoal through a battery-powered sampling pump operating at 50 cc/min. The charcoal was desorbed with carbon disulfide and analyzed by gas chromatography using NIOSH Method P&CAM 127. Toluene, xylene, isopropanol, methyl isobutyl ketone, and trimethylbenzene were quantitated. Three consecutive samples were taken over a total of six hours. For the remaining two hours of her 8-hour shift the printer typically leaves the printing room. Therefore, solvent exposure during that time was considered to be zero when determining 8-hour time-weighted averages.

The medical officer interviewed the printer and two other workers in nearby areas of the building.

## V. EVALUATION CRITERIA

Environmental evaluation criteria and the principle health effects of the substances evaluated in this study can be found in Table I. NIOSH recommended exposure limits were used as the evaluation criteria. The current ACGIH recommended threshold limit value (TLV) was used to evaluate trimethylbenzene, for which NIOSH has not yet developed a recommended standard.

When evaluating an exposure to substances, such as solvents, which affect the body in a similar fashion, their combined hygienic effect\* should be given primary consideration. That is, if the sum of the following fractions,

$$\frac{\text{exps. level}(1)}{\text{eval. crit.}(1)} + \frac{\text{exps. level}(2)}{\text{eval. crit.}(2)} + \dots + \frac{\text{exps. level}(n)}{\text{eval. crit.}(n)}$$

exceeds 1.0, then exposure to the mixture is considered excessive.<sup>2</sup>

Trimethylbenzene, as commonly used industrially, is primarily a mixture of the 1,2,4, and 1,3,5 isomers. The TLV refers to trimethylbenzene without specifying proportions of the isomers.<sup>2</sup>

In a 1956 study by Battig,<sup>3</sup> the inhalation of trimethylbenzene was associated with asthmatic bronchitis, anemia, and blood clotting abnormalities in a comparison between workers who had been exposed over a period of years to a 10-60 ppm hydrocarbon vapor containing over 80% trimethylbenzene and workers with similar exposure except for trimethylbenzene. The American Conference of Governmental Industrial Hygienist (ACGIH) recommended the TLV of 25 ppm for trimethylbenzene, primarily on the basis of that study. Very few other experiences of human exposure to trimethylbenzene have been studied. Known central nervous system effects of trimethylbenzene are headache, fatigue, and drowsiness.<sup>4</sup> High-level exposure of rats to trimethylbenzene produced lung, liver, and kidney damage.<sup>5</sup>

## VI. RESULTS

### Environmental

Qualitative analysis of the large volume air samples showed that acetone and various alkylbenzenes, mostly trimethylbenzenes, were the major hydrocarbon vapors generated during lacquer printing (using "Ceramic Coat-Clear Yellow" manufactured by Degussa Corporation). During solvent cleaning (using "Stripping Solvent 8525" manufactured by Neville Chemical Co.), mostly toluene, xylene, isopropanol, and methyl isobutyl ketone (MIBK) were generated.

\*Hygienic Effect =  $\frac{\text{exposure level}}{\text{evaluation criteria}}$

Personal breathing zone concentrations of the printing contaminants are listed in Table II. The printer was overexposed to trimethylbenzene which, at 29 ppm, represented the highest 8-hour TWA exposure of any of the contaminants and which also has the most stringent evaluation criterion of 25 ppm, resulting in a hygienic effect of 29/25 or 1.2. The total hygienic effect of the other hydrocarbons was 0.3, resulting in an overall hydrocarbon vapor concentration that was 1.5 times the recommended limit.

There was no local exhaust ventilation for the printing press during the NIOSH survey. A fairly effective dilution ventilation system was available. This consisted of an exhaust fan located on the wall near the printing press. However, it was noted that the printer frequently did not operate the fan during printing because changes in pressroom air, particularly humidity, were detrimental to the quality of the printed decals.

During printing the worker wore a 3M disposable Organic Vapor Respirator (Model 8712). The respirator appeared to be well-fitted and was replaced regularly as soon as solvent odors were detectable through the respirator.

#### Medical

The printer reported frequent headaches, eye tearing and redness, throat irritation, and lightheadedness while at work and a pronounced sense of exhaustion and somnolence in evenings after work. Lightheadedness clears after 10-15 minutes of breathing fresh air. The sense of exhaustion and somnolence continued for several hours, often resulting in her falling asleep at 6:30-7:00 PM. She thought the severity of these symptoms correlated with the amount of lacquer exposure. Workers in nearby locations reported noting strong solvent odors when they came in or near the printing area, but they were not aware of any health effects.

#### VII. CONCLUSION

The study showed that the screen printer was exposed to a hydrocarbon mixture (40% of which was trimethylbenzene) at a concentration that was 1.5 times the recommended limit. The group of symptoms reported was consistent with repeated and prolonged overexposure to hydrocarbon solvents. In particular, the reported headaches, fatigue, and somnolence would be expected with overexposure to trimethylbenzene.

#### VIII. RECOMMENDATIONS

The present respirator program for the screen printer should be considered as interim protection. For practical reasons, sound engineering controls are always preferable to the potentially numerous mechanical and human shortcomings inherent with the use of personal protective devices. The following guidelines, particularly the simple and straightforward contaminant-isolation, should be used to reduce solvent vapors below harmful levels. If, for some reason, these guidelines cannot be followed, it would be necessary to thoroughly investigate the respirator program to determine why adverse health effects still occur during printing and then modify and enforce the

written standard operating procedures accordingly (e.g. selection of a full face-piece mask to prevent eye irritation). As one more thoroughly investigates the other precautions that should be followed when a worker must remain overexposed to solvents [i.e., (1) frequent environmental monitoring; (2) baseline, annual, and termination medical examinations including neurological assessment, biological monitoring, and pulmonary function testing before assigning a respirator; (3) labeling and posting of hazardous environments; and (4) increased recordkeeping], the following guidelines become more appealing:

A. Contaminant Isolation

Some organic vapor exposure occurs during printing as the volatile portion of the inks or lacquers evaporate. However, in terms of surface area, the drying racks of numerous sheets of wet lacquer represent a far greater source of contamination. Drying racks should not remain in the work area after they are filled. Some commercial screen printing operations place their racks of wet printed material into "drying ovens" which are totally enclosed and exhausted to the outside. Another alternative would simply be to isolate the racks in the adjacent closed room (non-work area) and then maintain that room air at a negative pressure relative to the printing room.

B. Local Exhaust Ventilation

The present dilution ventilation system is not very useful since it is frequently not operated during printing. Local exhaust ventilation is capable of more efficient contaminant control with the additional bonus of using much lower air volumes, thereby maintaining pressroom conditions of temperature and humidity that are more conducive to printing quality control. A canopy-type exhaust hood located above the press could effectively control printing contaminants. Capture velocities of 100 feet per minute are generally considered acceptable for typical solvent vapors. In any case, "Industrial Ventilation - A Manual of Recommended Practice", published by ACGIH<sup>6</sup>, should be consulted before designing local exhaust ventilation.

C. Product Substitution

Trimethylbenzene has recommended exposure limits that are lower than most hydrocarbons commonly found in screen printing processes. It may be feasible to substitute the lacquer with one that contains relatively less toxic compounds. Current NIOSH, OSHA, and ACGIH criteria should be consulted before choosing a product. Of course, the necessary first step to this procedure is to insist that manufacturers furnish information defining the constituents of their products. Workers should also be kept apprised of this information, including any relevant health data.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and  
Report Prepared By:

Steven A. Lee, M.S.  
Industrial Hygienist  
Industrial Hygiene Section

Jay C. Klemme, M.D., M.P.H.  
Occupational Physician  
Medical Section

Originating Office:

Hazard Evaluations and Technical  
Assistance Branch  
Division of Surveillance, Hazard  
Evaluations, and Field Studies  
Cincinnati, Ohio

Report Typed By:

Patty Johnson  
Secretary  
Industrial Hygiene Section

X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of the report have been sent to:

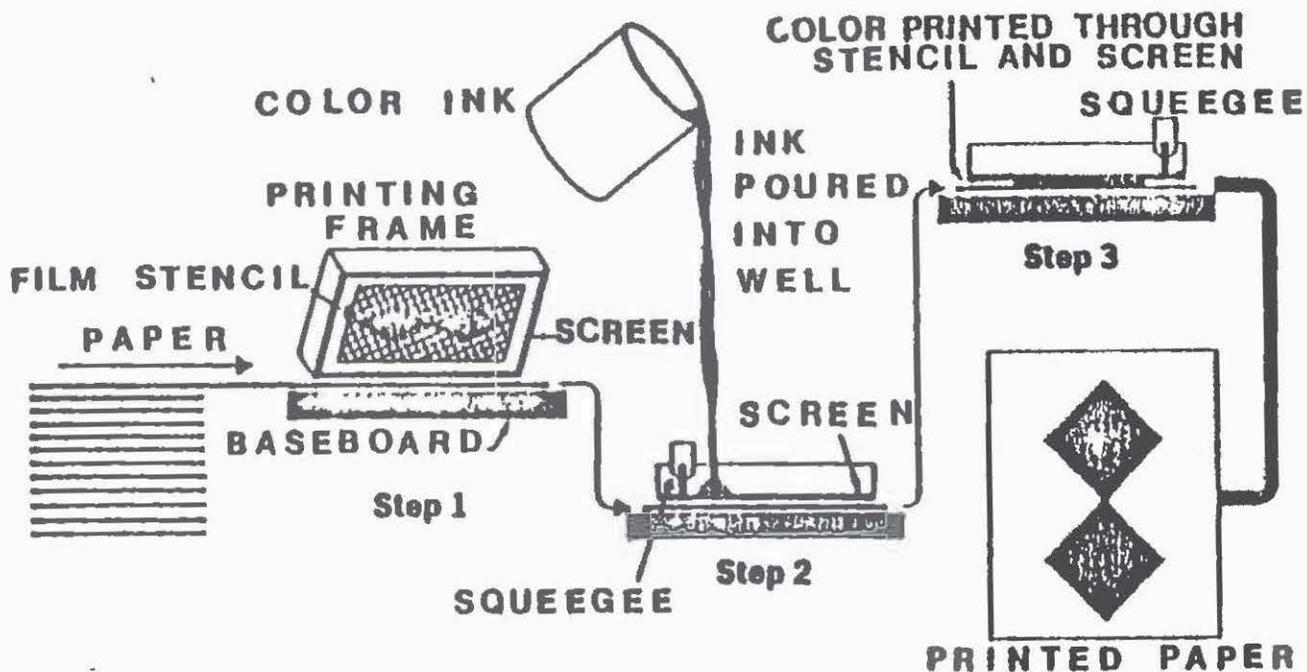
- a. Anchor Hocking Corporation
- b. The Screen Printer
- c. U.S. Department of Labor, Region III
- d. NIOSH, Region III

XI. REFERENCE

1. Printing Ink Handbook, ed 3. Harrison, NY, National Association of Printing Ink Manufacturers Inc., Product and Technical Publication Committee, 1976, 95 pp.
2. Documentation of Threshold Limit Values, fourth edition, American Conference of Governmental Industrial Hygienist, 1980. ACGIH, P.O. Box 1937, Cincinnati, Ohio 45201.
3. Battig, K., E. Grandjean, V. Turrian. Gesundheitsschaden nach langdauernder Trimethylbenzol-Exposition in einer Malerwerkstatt. Z. Praventivmed. 1:389-403 (1956).
4. Toxicology and Metabolism of Industrial Solvents, Ethel Browning, Elsevier Publishing Co., New York, 1965.

5. Battig, K., E. Grandjean, L. Rossi, J. Rickenbacher. Toxicologische Untersuchungen über Trimethylbenzol. Archiv für Gewerbepathologie und Gewerbehygiene 16:555-566 (1958).
6. Industrial Ventilation, A Manual of Recommended Practice, 16th ed. American Conference of Governmental Industrial Hygienist, 1980. ACGIH, P.O. Box 1937, Cincinnati, Ohio 45201.

# Screen Printing



BASIC PRINCIPLES OF SCREEN (POROUS) PRINTING

Adapted From Reference 1

TABLE I  
EVALUATION CRITERIA FOR HAZARDOUS SUBSTANCES  
ANCHOR HOCKING CORPORATION  
CHESTER, WEST VIRGINIA  
HETA 81-289

<u>CONTAMINANT</u>	<u>OSHA PERMISSIBLE EXPOSURE LIMIT</u>	<u>ACGIH THRESHOLD LIMIT VALUE</u>	<u>NIOSH RECOMMENDED STANDARD</u>	<u>PRINCIPLE HEALTH EFFECTS</u>
Toluene	200 ppm 300 ppm, 10 minute ceiling 500 ppm, peak	100 ppm 150 ppm, 15 minute ceiling	100 ppm 200 ppm, 10 minute ceiling	fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils, lacrimation (watering of the eyes), nervousness, muscular fatigue, insomnia, paresthesias (abnormal sensations)
Xylene	100 ppm	100 ppm 150 ppm, 15 minute ceiling	100 ppm 200 ppm, 10 minute ceiling	irritating of the eyes, mucous membranes and skin; in high concentrations dizziness, excitement, drowsiness, incoordination, staggering gait, loss of appetite, nausea, vomiting, abdominal pain.
MIBK	100 ppm	100 ppm 125 ppm, 15 minute ceiling	50 ppm	dermatitis; irritation of the eyes, nose and throat; nausea; headache; in high concentrations drowsiness, weakness, dizziness, and staggering gait.
Acetone	1,000 ppm	1,000 ppm*	250 ppm	irritation of the eyes, nose, throat, and skin; nausea; headache; in high concentrations drowsiness, weakness, dizziness, and staggering gait.
Isopropanol	400 ppm	400 ppm 500 ppm, 15 minute ceiling	400 ppm 800 ppm, 15 minute ceiling	irritation of eyes, nose, and throat; in high concentrations dizziness, drowsiness, and incoordination.
Trimethyl Benzene	---	25 ppm 35 ppm, 15 minute ceiling	---	headache, fatigue, drowsiness, anemia, respiratory irritation, asthmatic bronchitis.

\* Intended change to 750 ppm  
1000 ppm, 15 minute ceiling.

TABLE II

SCREEN PRINTER, PERSONAL-BREATHING ZONE CONCENTRATIONS  
OF ORGANIC VAPORS IN PARTS PER MILLION (ppm)

ANCHOR HOCKING CORPORATION  
CHESTER, WEST VIRGINIA  
HETA 81-289

<u>SAMPLING TIME</u>	<u>ACETONE</u>	<u>ISOPROPANOL</u>	<u>MIBK</u>	<u>TOLUENE</u>	<u>XYLENE</u>	<u>TRIMETHYLBENZENE</u>	
7:00AM - 9:30AM	19	3.5	0.5	5.4	4.9	34	
9:30AM - 12:00 Noon	25	6.1	0.8	9.5	7.4	47	
12:30PM - 1:30PM	8.7	45	5.7	40	38	31	
1:30PM - 3:30PM (zero exposure assumed)	--	--	--	--	--	--	
8-Hour Time-Weighted Average	15	8.6	1.1	9.7	8.6	29	<u>COMBINED EXPOSURE RATIO</u> 1.5
Evaluation Criteria	250	400	50	100	100	25	1.0