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MICHIGAN PRINTERS
CHICAGO, ILLINOIS

NIOSH INVESTIGATORS:
NANCY CLARK BURTON, MS
ROBERT MALKIN, DDS, DrPH

I. SUMMARY

In December 1992, the National Institute for Occupational Safety and Health (NIOSH) received a management request to evaluate worker exposures at Michigan Printers, a check and off-set printing facility in Chicago, Illinois. The request was prompted by management concerns when a former office employee developed symptoms (cough, rhinitis, headache, and rash) reportedly related to exposures to carbonless copy paper and print shop solvents used at this facility.

On February 9-10, 1993, NIOSH investigators conducted an industrial hygiene and medical survey. Personal breathing zone (PBZ) and area air samples were collected for organic solvents and metals. Work practices and engineering control measures were evaluated, and personal interviews were conducted with all employees.

None of the PBZ exposures or area concentrations for isopropanol (53 to 132 parts per million [ppm]), isobutanol (0.15 to 0.91 ppm), 1,1,1-trichloroethane (0.11 to 0.23 ppm), or toluene (1.09 to 5.03 ppm) exceeded their respective occupational evaluation criteria. Very low levels of beryllium, calcium, copper, iron, magnesium, and zinc (range: 0.02 to 1.05 micrograms per cubic meter [$\mu\text{g}/\text{m}^3$]) were detected in the two area samples collected. The ventilation units and humidifier appeared to be well maintained. One of the 11 employees interviewed reported cough and chest tightness, which the worker associated with the alcohols used with the offset press. Although a previous employee had reportedly experienced symptoms of cough, rhinitis, headache, and rash when using carbonless copy paper, NIOSH investigators could not find any symptoms which were related to the use of carbonless copy paper or organic solvents. Some deficiencies were identified in the material safety data sheet (MSDS) records and in the use of appropriate personal protective equipment.

The results indicate that workers in the printing facility were not overexposed to organic solvents or metals on the day of the survey. Recommendations for updating the hazard communications file and improving employee comfort can be found in Section VIII of this report.

KEYWORDS: SIC 2752 (Commercial Printing), isopropanol, toluene, 1,1,1-trichloroethane, ventilation, metals, carbonless paper.

II. INTRODUCTION

On February 9-10, 1993, National Institute for Occupational Safety and Health (NIOSH) investigators conducted a health hazard evaluation (HHE) at the Michigan Printers facility in Chicago, Illinois. This site visit was made in response to a management request to evaluate chemical exposures from the printing operations. The request concerned a report that a former employee had suffered adverse reactions to carbonless copy paper and solvents used in the printing process. Although this employee was no longer at this facility, the company was concerned about other worker exposures. In response to this request, air monitoring for organic solvents and metals, and personal interviews with current employees, were conducted.

III. BACKGROUND

The Michigan Printers facility is housed in a one-story concrete block building with concrete floors which had been constructed in 1964. The print shop produces checks, brochures, newsletters, signs, and advertisements and has been in production at this site since 1976. The facility employs 12 full-time staff, all on the day shift. Figure 1 is a sketch of the building (not to scale). There are four carpeted office areas and a computer center located in the front of the building. The print shop is divided into two sections: off-set printing and check production. A photographic equipment area with a camera and dark room is located in the check production section. The check production area includes a small press which uses petroleum-based and magnetic inks, a check cutting and sewing assembly area, and a shrink wrap/mail area. The off-set printing area includes a large off-set printer, a smaller off-set printer, and storage and processing areas. The large off-set press uses petroleum-based inks with a 25% isopropanol solution during the printing process, and a gas burner to dry the ink. According to management, organic solvents are used to clean the presses every week. The brand of carbonless copy paper, which has been used since 1992, is different from the two types that the former employee had used.

Smoking is not allowed in the building. The print shop is served by two forced air package heating units - one for each section. One unit also functions as an air-conditioner (check production area). Windows can be opened in the print shop areas. Both units were functioning in the heat mode during the site visit. There are also overhead electric heaters to provide additional heat. Outside air intakes for the two units are located on the roof on the west side and set for minimum outside air intake (10%). The facility is located beside one of the runways of the Chicago O'Hare airport. According to staff, jet fumes are noticeable in the facility when there is a strong westerly wind. There are four propeller exhaust fans in the roof - two in each section. The facility uses a free-standing humidifier in the check press/assembly half of the

building. The ventilation units are reportedly serviced monthly by print shop staff. The air intakes have primary low-efficiency (25%) fiberglass filters, which are changed monthly, and more efficient filters, which are changed as needed based on a visual inspection. The humidifier is reportedly cleaned and disinfected, with a biocide added, on a monthly basis.

IV. METHODS

INDUSTRIAL HYGIENE

Personal breathing zone (PBZ) and area air samples were collected for the compounds identified below. The facility's Material Safety Data Sheets were reviewed, and the ventilation systems were evaluated. Air flow patterns were visually evaluated using smoke tubes.

A. *Organic Solvents*

Two PBZ and five area air samples were collected on charcoal tubes at a flowrate of 0.2 liters per minute (l/min). One area sample was used for qualitative analysis to identify major constituents by gas chromatography/mass spectroscopy (GC/MS) analysis. The remaining charcoal tubes were desorbed with carbon disulfide and screened by gas chromatography/flame ionization detector (GC-FID), according to NIOSH Methods 1003, 1500, and 1501 for the major constituents.^{1,2,3} Total C7-C9 hydrocarbons were quantitated against n-hexane. The laboratory-assigned analytical limit of detection (LOD) and limit of quantitation (LOQ); and the corresponding minimum detectable concentration (MDC) and minimum quantifiable concentration (MQC), assuming a sample volume of 85 liters, are as follows:

Analyte	LOD mg/sample*	LOQ mg/sample	MDC ppm**	MQC ppm	Minimum Volume (liters)
Isopropanol	0.05	0.17	0.24	0.82	85
Isobutanol	0.04	0.14	0.16	0.54	85
Hexanes	0.006	0.02	0.02	0.07	85
1,1,1-trichloroethane	0.007	0.022	0.02	0.05	85
Toluene	0.004	0.014	0.01	0.04	85

- * = milligrams per sample (mg/sample)
- ** = parts per million (ppm)

The isopropanol results are semi-quantitative due to breakthrough. The laboratory-assigned LOD and LOQ; and calculated MDCs and MQCs, assuming a sample volume of 85 liters, for C7-C9 hydrocarbons are as follows:

Analyte	LOD mg/sample	LOQ mg/sample	MDC mg/m ³	MQC mg/m ³	Minimum Volume (liters)
C7-C9 Hydrocarbons	0.004	0.013	0.05	0.15	85

B. Metals

Two area air samples were collected on mixed-cellulose ester filters (37 millimeters [mm] diameter, 0.8 micrometers [μ m] pore size) using a flowrate of 2.0 l/min. The samples were analyzed for metals according to NIOSH Method 7300.⁴ In the laboratory, the samples were wet-ashed with concentrated nitric and perchloric acids and the residues were dissolved in a dilute solution of the same acids. The resulting sample solutions were analyzed by inductively-coupled plasma atomic emission spectrometry.

MEDICAL

To determine whether or not other employees were experiencing symptoms similar to those the former employee reportedly had (cough, nasal congestion, headache, and rash), all 11 employees present at work on the days of the site visit were interviewed.

V. EVALUATION CRITERIA

To assess the hazards posed by workplace exposures, industrial hygienists use a variety of environmental evaluation criteria. These criteria propose exposure levels to which most employees may be exposed for a normal working lifetime without adverse health effects. These levels do not take into consideration individual susceptibility, such as pre-existing medical conditions, or possible interactions with other agents or environmental conditions. Evaluation criteria change over time with the availability of new toxicologic data.

There are three primary sources of environmental evaluation criteria for the workplace: 1) NIOSH Recommended Exposure Limits (RELs)⁵, 2) the American Conference of

Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs)⁶, and 3) the U.S. Department of Labor Occupational Safety and Health Agency (OSHA) Permissible Exposure Limits (PELs).⁷ In July 1992, the 11th Circuit Court of Appeals vacated the 1989 Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs will continue to enforce the 1989 limits. NIOSH encourages employers to follow the 1989 limits or the NIOSH RELs, whichever is lower. The OSHA PELs may reflect the feasibility of controlling exposures in various industries where the agents are used; whereas the NIOSH RELs are based primarily on concerns related to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and the OSHA PELs in this report are the 1971 criteria.

A. *Isopropanol*

Isopropanol is an irritant of the eyes and mucous membranes. High exposures can cause central nervous system (CNS) depression.⁸ The NIOSH REL, ACGIH TLV[®], and OSHA PEL for isopropanol are 400 ppm as a time-weighted average (TWA).

B. *Isobutanol*

At high concentrations, isobutanol is associated with CNS depression. Exposure has been associated with mild irritation of the skin, eyes, and throat.^{5,8} The NIOSH REL for isobutanol is 50 ppm as a 10-hour TWA. The ACGIH TLV[®] for isobutanol is 50 ppm as an 8-hour TWA. The current OSHA PEL for isobutanol is 100 ppm as an 8-hour TWA. OSHA had lowered the PEL to 50 ppm in 1989 under the Air Contaminants Standard.

C. *Hexanes*

n-Hexane is an upper respiratory irritant and causes CNS depression. Chronic exposure can cause peripheral neuropathy. Skin exposure can cause irritation and erythema (redness).^{5,8} The NIOSH REL for n-hexane is 50 ppm as a 10-hour TWA. The ACGIH TLV[®] for n-hexane is 50 ppm and for all other isomers is 500 ppm, as 8-hour TWAs. The current OSHA PEL for n-hexane is 500 ppm as an 8-hour TWA. OSHA had lowered the PEL to 50 ppm in 1989 under the Air Contaminants Standard.

D. *1,1,1-trichloroethane*

Exposure to 1,1,1-trichloroethane causes CNS depression and has been associated with cardiovascular effects and liver injury at high levels.^{5,8} The NIOSH REL for 1,1,1-trichloroethane-hexane is 350 ppm as a ceiling level (never to be exceeded). The ACGIH TLV® and OSHA PEL for 1,1,1-trichloroethane is 350 ppm as an 8-hour TWA.

E. *Toluene*

Toluene exposure has been associated with CNS depression. Symptoms may include headache, dizziness, fatigue, confusion, and drowsiness. Exposure may also cause irritation of the eyes, respiratory tract, and skin.^{5,8} The NIOSH REL for toluene is 100 ppm as a 10-hour TWA. The ACGIH TLV® for toluene is 50 ppm as an 8-hour TWA. The current OSHA PEL for toluene is 200 ppm as an 8-hour TWA. OSHA had lowered the PEL to 100 ppm in 1989 under the Air Contaminants Standard.

F. *Carbonless Copy Paper*

Carbonless paper has been associated with skin and mucous membrane irritation of the eyes, nose, and throat.^{9,10} It has also been associated with contact dermatitis and the respiratory effects of shortness of breath, cough, and respiratory depression.^{10,11}

VI. RESULTS

INDUSTRIAL HYGIENE

A. *Organic Solvents*

The two PBZ and four area sample results for isopropanol, isobutanol, hexanes, 1,1,1-trichloroethane, toluene, and C7-C9 hydrocarbons are given in Table 1. None of the PBZ or area concentrations for isopropanol (PBZ: 100 and 109 ppm; area: 53 to 132 ppm), isobutanol (PBZ: 0.28 and 0.91 ppm; area: 0.15 to 0.51 ppm), 1,1,1-trichloroethane (PBZ: 0.23 and 0.19 ppm; area: 0.11 to 0.18 ppm), and toluene (PBZ: 2.49 and 5.03 ppm; area: 1.09 to 3.22 ppm) exceeded the current occupational evaluation criteria. Total C7-C9 hydrocarbons ranged from 19.2 and 41.88 milligrams per cubic meter (mg/m³) for the PBZ exposures and 11.25 to 30.31 mg/m³ for area concentrations.

B. *Metals*

Very low levels of beryllium, calcium, copper, iron, magnesium, and zinc (range: 0.02 to 1.05 micrograms per cubic meter [$\mu\text{g}/\text{m}^3$]) were detected for the two area samples collected. The highest exposure (1.05 $\mu\text{g}/\text{m}^3$) was measured for calcium. Calcium has no occupational evaluation criteria at the current time.

C. *Observations*

Air flowed from the offices into the print shop areas during the site visit. This and the fact that the doors between the offices and print shop were kept closed helped to keep print shop contaminants from entering the office areas. Air flowed from the check production area into the off-set press area. The ventilation units appeared to be working as designed. Exhaust fans over presses were not operating on the day of the site visit (they had not been switched on). The humidifier was clean and clear of visible contamination.

Employees were not wearing any gloves when using photographic compounds, which according to the respective material safety data sheet (MSDS), can cause skin irritation and dermatitis (phosphoric acid and acetone). MSDSs were not available for all the inks being used at the facility at the time of the site visit. According to available MSDSs, the inks in use contained petroleum hydrocarbons.

MEDICAL

Out of the 11 workers interviewed, one employee reported odors, tightness in the chest, and cough which he associated with odors emanating from the large press, which used isopropanol as a solvent. Employees reported no other symptoms that they associated with working at Michigan Printers. No rashes, respiratory symptoms, or CNS symptoms were reported by employees.

VII. DISCUSSION AND CONCLUSIONS

At this facility, NIOSH investigators did not find any symptoms which were related to the use of carbonless copy paper or organic solvents. None of the measured organic solvents or metals exceeded their respective occupational exposure criteria. The ventilation systems and humidifier appeared well maintained. Some deficiencies were identified in the MSDS records and in the use of appropriate personal protective equipment.

VIII. RECOMMENDATIONS

Based on the results and observations of this survey, the following recommendations are offered to correct identified deficiencies and optimize employee comfort.

- 1) In accordance with OSHA's Hazard Communication standard, updated MSDSs should be obtained from the manufacturer and kept in a location readily available to employees.¹²
- 2) To prevent skin conditions, rubber gloves should be used when handling photographic chemicals. The gloves should be changed as needed to prevent skin contact with the chemicals used.
- 3) To reduce isopropanol exposures, the exhaust fans over the off-set press should be turned on while the press is operating.
- 4) To avoid microbial contamination, a preventive maintenance program for the humidifier should be continued.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by: Nancy Clark Burton, M.P.H., M.S.
Industrial Hygienist
Industrial Hygiene Section

Robert Malkin, D.D.S., Dr.P.H.
Supervisory Epidemiologist
Medical Section

Analytical Support: Data Chem, Inc.
960 West Leroy Drive
Salt Lake City, Utah

Division of Physical Sciences and
Engineering

Report Formatted By: Ellen E. Blythe
Office Automation Assistant
Industrial Hygiene Section

Originating Office: Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

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1. Michigan Printers
2. Employee Representative
3. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

Volatile Organic Solvent Results

Michigan Printers
Chicago, Illinois
HETA 93-0366

Location	Sample Time	Sample Volume (l)*	Isopropanol (ppm)**	Isobutanol (ppm)	Hexanes (ppm)	1,1,1-trichloroethane (ppm)	Toluene (ppm)	C7-C9 Hydrocarbons (mg/m ³)#
Check Press Area	7:21-3:29	97	80	0.26&	0.22	0.18	2.02	16.82
Receptionist Area	7:15-3:19	97	53	0.15&	0.22	0.11	1.09	11.25
Break Area	7:26-3:15	93	132	0.51	0.69	0.17	3.22	30.31
Check Processing	7:25-3:22	95	91	0.21&	0.18	0.13	1.50	17.80
Check Sewing Oper.	7:22-2:32	85	100	0.28&	0.20	0.23	2.49	19.20
Off-set Press Oper.	7:20-3:12	96	109	0.91	0.18	0.19	5.03	41.88
NIOSH REL			400	50	100	350 (Ceiling)	100	
OSHA REL			400	100	500	350	200	
ACGIH TLV®			400	50	500	350	50	
Minimum Detectable Concentration (MDC)		85	0.24	0.16	0.02	0.02	0.01	0.05
Maximum Quantifiable Concentration (MQC)		85	0.82	0.54	0.07	0.05	0.04	0.15

* = liters (l)

** = parts per million (ppm)
= milligrams per cubic meter (mg/m³)
& = between MDC and MQC