Nuisance Odors from a Neighboring Printing Facility-Air Quality Evaluation at a Label Distributing Company

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Health Hazard Evaluation Report
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NIOSH *National Institute for Occupational Safety and Health*

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ACKNOWLEDGMENTS

ABBREVIATIONS

ACGIH®	American Conference of Governmental Industrial Hygienists
CFR	Code of Federal Regulations
DOL	Department of Labor
GA	General area
GC/MS	Gas chromatography/mass spectrometry
HHE	Health hazard evaluation
HVAC	Heating, ventilating and air conditioning
IEQ	Indoor environmental quality
Lpm	Liters per minute
mg	Milligrams
mg/m^3	Milligrams per cubic meter
mL	Milliliter
MSDS	Material safety data sheet
NAICS	North American Industry Classification System
NIOSH	National Institute for Occupational Safety and Health
NMAM	NIOSH Manual of Analytical Methods
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
ppm	Parts per million
REL	Recommended exposure limit
STEL	Short-term exposure limit
TD	Thermal desorption tube
TLV®	Threshold limit value
TVOC	Total volatile organic compound
TWA	Time-weighted average
VOC	Volatile organic compound

Highlights of the NIOSH Health Hazard Evaluation

NIOSH received a management request for an HHE at Schreiner Label Tech (Schreiner) in Southfield, Michigan. The company submitted the HHE request because workers were reporting eye, nose, and throat irritation, which they associated with exposure to volatile organic compounds (VOCs) from printing ink solvents used in a neighboring facility. NIOSH investigators conducted the evaluation in November 2006.

What NIOSH Did

- We collected air samples for VOCs.
- We looked for how these VOCs were entering the Schreiner facility.
- We talked to the workers about their health concerns.

What NIOSH Found

- Most workers reported health symptoms (watery eyes, runny nose, sneezing, sinus problems, and headache) that improved or went away when the workers left.
- There were cracks in the common wall between the Schreiner facility and the printing company.
- The concentrations of VOCs did not exceed occupational exposure limits, but some individual compounds were above their odor threshold.
- The Schreiner facility was under negative air pressure, so it was drawing in the chemical vapors from the neighboring printing company.

What Schreiner Management Can Do

- Hire a ventilation expert who can balance the facility's ventilation system so that it is under positive pressure.
- Reseal the cracks in the common wall to make it airtight and prevent air being pulled through the cracks.

What Schreiner Employees Can Do

- Report unusual odors to your manager.
- See your doctor if serious health symptoms persist.

Summary

While airborne concentrations of VOCs measured at the Schreiner facility were below applicable occupational exposure limits, six of the seven employees reported eye irritation and headaches. NIOSH recommended placing the Schreiner facility under positive pressure and sealing the cracks in the common wall between the two facilities.

In August 2006, NIOSH received a management request from Schreiner Label Tech (Schreiner) for an HHE at their facility in Southfield, Michigan. Employees at the Schreiner facility were reporting watery eyes, runny nose, scratchy throat, sneezing, and headaches that they believed were the result of exposure to chemicals from the printing company next door. The Schreiner facility consists of several offices and a small warehouse from which labels and self-adhesive products are distributed. It occupies a suite next to a printing company in an industrial mall. MSDSs for the inks used by the printing company indicate that the inks contain petroleum distillates.

NIOSH investigators conducted an evaluation of the Schreiner facility from November 27–28, 2006. During the evaluation we observed how air flowed between the Schreiner facility and the printing company, collected GA air samples for VOCs in both facilities, and interviewed Schreiner facility employees.

We found that air flowed from the printing company to the Schreiner facility indicating that the Schreiner facility was under negative air pressure relative to the printing company. In addition, several cracks were found in the wall separating the Schreiner facility and the printing company. These openings and pressure differentials allowed printing ink vapors to enter the Schreiner facility. We found similar chemical compounds in the samples collected in the two facilities; concentrations in the printing company were higher. Area air sampling results for samples collected in both facilities indicated that concentrations of 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, toluene, xylene, and petroleum distillates were below applicable occupational exposure limits. However, concentrations of toluene and xylene were above their odor thresholds.

Placing the Schreiner facility under positive pressure and sealing the cracks in the common wall should reduce the concentration of VOCs and reduce employees' symptoms.

Keywords: NAICS 322299 (All Other Converted Paper Product Manufacturing), VOC, petroleum distillates, IEQ, printing ink, allergy, headache, odor threshold

Introduction

In August 2006, NIOSH received an HHE request from the Sales Director at Schreiner Label Tech, Inc. (Schreiner) in Southfield, Michigan. In the request he asked for assistance in evaluating the IEQ at this facility due to employees' reports of chemical odors and subsequent watery eyes, runny nose, sneezing, and headaches. He was concerned that the adjacent commercial printing company was the source of the odors. Schreiner moved into the building in July 2005, and their workers started reporting symptoms shortly thereafter. We contacted the management at the printing company and requested permission to enter their facility to collect GA air samples for comparison with samples collected at the Schreiner facility. We also requested copies of MSDSs for the printing inks used by the printing company. We conducted an evaluation of the two facilities from November 27–28, 2006, during which we identified contaminant pathways and collected GA samples for VOCs. We also evaluated air pressure differentials between the two facilities. We conducted interviews with Schreiner employees to discuss health symptoms they had experienced and whether they believed these symptoms were related to workplace exposures.

Assessment

The sampling and analytical methods used for this evaluation are discussed in more detail in Appendix A. We collected four GA air samples on TD tubes for qualitative analysis for VOCs, two in the Schreiner facility and two in the printing company. We also collected full shift GA air samples for VOCs on charcoal tubes in both facilities. Based on results from the TD tubes, we requested quantitative laboratory analysis of the charcoal tubes for 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, toluene, and xylene. Following a review of the MSDSs provided by the printing company, we also collected GA air samples on charcoal tubes in both facilities for petroleum distillates in the printing inks.

We used a photoionization detector to measure TVOCs outside and inside each facility and along several large cracks in the interior cinder block wall separating the two facilities. These cracks were visible in the unfinished wall in the Schreiner facility warehouse. The cinder block wall in the administrative area was covered with wallboard so we could not see if any cracks were present. We used ventilation smoke tubes to determine if the Schreiner facility was under positive or negative air pressure relative to the printing company. We also stood outside the entrance to the Schreiner facility and released smoke at the bottom of the door while observing the direction of flow. [Smoke flowing into the Schreiner

Assessment (continued)

facility would indicate that it was under negative pressure.]
We conducted individual interviews with all seven Schreiner employees. These interviews covered employment history, medical history, and symptom description.

Results and Discussion

The concentrations of VOCs in air were below applicable occupational exposure limits and levels that have been associated with health effects. However, airborne concentrations for toluene and xylene were above their odor thresholds which may account for the solvent-type odor in the two facilities. The laboratory identified 56 chemicals on the TD tubes. The chromatographic patterns of the TD tube samples suggested that the air samples contained a mixture of solvents with a wide molecular weight range. Table 1 presents air sample results for 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, toluene, and xylene, the most prevalent chemicals seen on the chromatographs. All concentrations were 10–100 times lower than their respective NIOSH REL-TWA or OSHA PEL-TWA (see Appendix B for explanation and definition of these exposure limits). Results for petroleum distillates (as mineral spirits) were 14 mg/m^3 for one sample collected in the Schreiner facility's reception area, and 50 and 56 mg/m^3 for two samples collected near the printing press next door at the printing facility. These concentrations were well below the NIOSH REL of 350 mg/m^3 and OSHA PEL of 500 mg/m^3 for petroleum distillates, expressed as TWAs over an entire work day.

The TVOC concentrations in the Schreiner facility ranged from 2.8 to 3.1 ppm in the administrative area and 8.8 ppm in the warehouse. The outdoor TVOC concentration was 0.1 ppm. In the printing facility, the TVOC concentrations were higher than at the Schreiner facility, ranging from 2.4 ppm in the foyer to 19.4 ppm near the printing press. These results, along with the results for the charcoal tube GA air samples, confirmed that similar chemicals were present in both facilities and that VOC concentrations were higher at the printing company than at the Schreiner facility.

The two businesses are separated by a cinder block wall extending to the ceiling. During a walk-through of the facilities we noticed the sealant applied to the cracks in the cinder block wall was dry and cracked. We suspected that VOC migration from the printing company was occurring because the Schreiner facility was under negative air pressure relative to the printing company.

Smoke released at the bottom of an entry door flowed rapidly into the Schreiner facility, confirming that it was under negative pressure relative to outdoors. Smoke released near several cracks found in the wall separating these two companies also flowed into the Schreiner facility, confirming that it was under negative pressure relative to the printing company. Each facility has its own independent HVAC system.

The seven Schreiner employees interviewed worked an average of 38 months with a range from 7 to 90 months. Median length of employment was 17 months. Symptoms reported by employees appeared to begin or worsen within one week of relocation of the business to the current property in July 2005. Eye irritation and headaches were reported by six of seven employees. Among the six employees reporting eye irritation and headaches, four had sought medical care and three reported missing work because of their symptoms. Respiratory and sinus problems were reported by three of seven employees; two employees reported pre-existing asthmatic symptoms that worsened after relocation to the new facility. All employees with symptoms stated that they perceived that their symptoms worsened when production levels were higher at the neighboring printing facility; employees reported that they could hear the large printing press in the adjacent facility when it was operating.

No employees reported past occupational exposure to chemicals or solvents; most had worked in sales or office jobs. Additionally, none reported hobbies or other off-work activities or employment with other than routine chemical exposures, such as household cleaning products. Two employees whose offices shared a common wall with the neighboring printing facility complained of noise associated with the printing presses.

Conclusions

Our sampling results showed that airborne chemical concentrations at the Schreiner facility were below their applicable occupational exposure limits. While other solvents were present at the Schreiner facility, toluene and xylene were most likely responsible for chemical odors at the facility because their air concentrations were above their odor thresholds. Additionally, as we mention in our evaluation criteria section (see Appendix B), some individuals may experience symptoms from exposures to low concentrations of airborne chemicals. The following conclusions are based on our air sampling results, evaluation of contaminant pathways, and employee interviews:

- The Schreiner facility was under negative air pressure in relation to the printing company and this contributed to the migration of VOCs through cracks in the wall separating the two companies.
- At the time of this evaluation, the VOC concentrations at the Schreiner facility did not exceed applicable occupational exposure limits.
- Employee interviews suggest that the symptoms reported by most workers were related to the presence of chemical odors in the Schreiner facility.

Recommendations

Implementing the following recommendations should lead to a decrease in chemical odors within the facility and to improvements in employee symptoms.

1. Request that the property manager hire an HVAC consultant to evaluate the ventilation system and make modifications to ensure that it can be maintained under positive pressure relative to adjacent companies and outdoors. Turning off the attic and lunch room exhaust fans would only be a temporary solution to maintain appropriate air balance and should not be relied on as a long-term solution.
2. Reseal the cracks in the common wall with a more effective and durable sealant that will not crack. When possible, cracks should be sealed from both sides of the wall for maximum effectiveness.

Table 1. VOC Air Sample Results

Location	Sample Time (minutes)	Concentration expressed in mg/m^3			
		1,2,4-TMB[a]	1,3,5-TMB	Toluene	Xylene
Top of printing press control panel	430	5.9	2.7	2.15	1.6
Back end of printing press	433	6.9	3.0	2.3	1.8
40” offset press	429	5.5	2.6	2.6	1.8
29” offset press	422	6.1	2.2	2.3	1.7
Schreiner reception area	460	1.7	0.77	0.65	0.34
Schreiner cubicle	457	1.7	0.60	0.65	0.35
Schreiner warehouse	456	1.9	0.69	0.96	0.43
NIOSH up to 10 hour recommended exposure limit-time weighted average (REL-TWA)		125	125	375	435
OSHA 8-hour permissible exposure limit-time weighted average (PEL-TWA)		None	None	754	435
Minimum detectable concentration (MDC)[b]		0.02	0.02	0.02	0.04
Minimum quantifiable concentration (MQC)[c]		0.07	0.06	0.10	0.20
Odor threshold[d]		12	12	0.60	1.4-3.7

[a]TMB = trimethylbenzene
[b] MDC was calculated by dividing the analytical methods limit of detection (LOD) by an air sample volume of 0.022 m^3.
[c] MQC was calculated by dividing the analytical methods limit of quantitation (LOQ) by an air sample volume of 0.022 m^3.
[d] Odor thresholds were selected from the 3M 2006 Respirator Selection Guide. 3M selected odor threshold from the VOCBASE (a database published by the National Institute of Occupational Health Denmark) and the American Industrial Hygiene Association (AIHA) publication, “Odor Thresholds for Chemicals with Established Occupational Health Standards.” It should be noted that the determination of odor thresholds was performed by subjecting a panel of individuals without anosmia or hypersensitivity to the chemicals. Some individuals may be able to smell these chemicals at much lower concentrations while others may not be able to smell them at higher concentrations. It should be noted that panel members were presented single pure chemicals, while in a work environment a mixture of many chemicals may be found.

Comments: (1) Benzene was not detected (concentrations less than 0.02 mg/m^3); (2) Ethylbenzene was present in trace concentrations (between 0.02 and 0.10 mg/m^3).

Appendix A: Methods

We collected two GA air samples using TD tubes at the Schreiner facility and two at the printing company. The TD tubes samples were collected at a flow rate of 0.050 Lpm for approximately 2 hours. The TD tubes were analyzed by GC/MS per NIOSH Method 2549 [NIOSH 2007]. Because the objective of the sampling and analysis was to identify the chemicals present in the two facilities, the laboratory spiked a series of reference materials (aromatic 100, kerosene, gasoline, mineral spirits, varnish makers' and painters' naptha, stoddard solvent, and diesel fuel) onto TD tubes and analyzed them with the sample set. The chromatographic patterns produced by the spiked samples were compared to the field samples to assist in defining the source of the chemicals present at the sampling site.

We collected seven GA air samples (four at the printing company and three at the Schreiner facility) on charcoal tubes (50/100 mg) and requested analysis for the chemicals that were most prevalent on the TD tubes (1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, toluene, and xylene) per NIOSH Method 1501 [NIOSH 2007]. We also collected three air samples on charcoal tubes (two at the printing company and one at the Schreiner facility) and analyzed them for petroleum distillates per NIOSH Method 1550 [NIOSH 2007]. We used a flow rate of 0.050 Lpm for the charcoal tubes and a sampling period of 7–8 hours.

We used a RAE Systems ToxiRAE PGM-30 PID equipped with a 10.6 electron volt lamp and calibrated with 100 ppm isobutylene to measure TVOCs outdoors, in the two facilities, and at the cracks in the cinder block wall [RAE Systems 2007].

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Appendix B: Evaluation Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or 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 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 become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH RELs [NIOSH 1992], (2) ACGIH® TLVs® [ACGIH 2006], and (3) the US DOL OSHA PELs [CFR 2003]. Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and STELs. An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A TWA exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term [NIOSH 2005].

Specific standards for acceptable airborne concentrations of contaminants in the non-industrial indoor environment do not exist. Measurement of indoor environmental contaminants has seldom proved helpful in determining the cause of symptoms except where there are unusual sources, or a proven relationship between specific exposures and disease. With few exceptions, concentrations of frequently measured chemical substances in the indoor work environment fall well below the published occupational standards or recommended exposure limits set by NIOSH, OSHA, and ACGIH.

Volatile Organic Compounds

This is a large class of organic chemicals (containing carbon) that have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. These VOCs are emitted in varying concentrations from many sources, including carpeting, fabrics, adhesives, solvents,

paints, cleaners, waxes, cigarettes, and combustion sources. IEQ studies have measured widely ranging VOC concentrations in indoor air, as well as differences in the mixtures of compounds present. However, concentrations are usually several times lower than any occupational standards, except in rare cases with unusual sources. A measurement of TVOCs has been used in some studies, attempting to predict certain types of health effects, but results have been inconsistent [Molhave 1991; Levin 1998]. Currently no guideline or standard exists for VOCs in nonindustrial workplaces. However, there have been some studies that show that mixtures of low levels of VOCs can cause sensory irritation responses from those exposed. Human responses can include perception of poor IEQ or "general discomfort"; irritation to the eyes, nose, and throat; discomfort due to odor; and headache. It is difficult to predict health effects from exposures to VOCs because they may depend on personal characteristics such as age, gender, sensitivity, and general health status.

The European community revised the concept of TVOC measurement to include the identification and quantification of 67 specific chemicals [Neilson et al. 1996]. This is outlined in a report by the Nordic Committee on Building Regulations, which recommends 26 chemical guidelines and presents toxicologically-based methodology for preparing more. Although important to IEQ research, these guidelines are still two to three orders of magnitude higher than typical indoor VOC concentrations [Levin 1998; Brown et al. 1994]. IEQ studies have measured wide ranges of VOC concentrations in indoor air as well as differences in the mixtures of chemicals which are present. Research suggests that the irritant potency of these VOC mixtures can vary. The use of this TVOC indicator, however, has never been standardized. Some researchers have compared levels of TVOCs with symptoms similar to those of concern among Schreiner facility employees (such as headache and irritative symptoms of the eyes, nose, and throat). However, neither NIOSH nor OSHA currently have specific exposure criteria for VOC mixtures in the nonindustrial environment. Research conducted in Europe suggests that reports of symptoms by building occupants may be more likely to occur when TVOC concentrations increase. Considering the difficulty in interpreting TVOC measurements, caution should be used in attempting to associate adverse health effects with specific TVOC concentrations.

Petroleum Distillates

The term petroleum distillate refers to numerous chemical products derived from the distillation of petroleum. Petroleum distillates are a mixture of aliphatic and aromatic hydrocarbons that include; mineral spirits or stoddard solvent, kerosene, and naptha. Petroleum distillates are a colorless liquid with an odor like gasoline or kerosene. Since the odor threshold of each of the constituents of petroleum distillates is below applicable occupational exposure limits, it is considered a chemical with adequate warning properties [NIOSH 1981]. In printing inks, petroleum distillates are used as a solvent. Inhalation of petroleum distillates vapors may cause, eye, nose, and throat irritation, dizziness, nausea, or headaches [NIOSH 2005]. Contact with petroleum distillates may produce skin irritation. NIOSH has an REL-TWA for petroleum distillates of 350 mg/m^3 and a ceiling limit of 1800 mg/m^3. OSHA has a PEL-TWA of 2000 mg/m^3 for petroleum distillates.

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Acknowledgements and Availability of Report

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (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 (OSHA) 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 employers 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.

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Copies of this report have been sent to employee and management representatives at Schreiner Label Tech and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. The report may be viewed and printed from the following internet address: http://www.cdc.gov/niosh/hhe. Copies may be purchased from the National Technical Information Service at 5825 Port Royal Road, Springfield, Virginia 22161.

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