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SPORTING HILL ELEMENTARY
MECHANICSBURG, PENNSYLVANIA

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SUMMARY

On April 9, 1991, NIOSH received a request for technical assistance from the Bureau of Occupational and Industrial Safety in Harrisburg, Pennsylvania. The request concerned complaints of an odor and health symptoms at Sporting Hill Elementary in Mechanicsburg, Pennsylvania. The health symptoms reported included headaches, stomachaches, dizziness, and respiratory problems. The suspected sources of the odor were chemical products previously used during renovation of the school. Specifically an organic solvent used to remove tile mastic, and a carpet adhesive.

An industrial hygiene survey was conducted April 31 and May 1, 1991. Ten area air samples were collected to measure the concentrations of volatile organic compounds (VOCs) in various locations of the building. Qualitative analysis of the samples indicated that the principle source of the VOCs measured in the building was the solvent mastic remover. VOCs present in the air samples were subsequently quantified using the mastic remover as a standard. The area air concentrations of total VOCs ranged from non-detected to 2.1 mg/m³.

Occupational guidelines specifically for the chemical mixture used in the mastic remover do not currently exist. The concentrations were well below the exposure guideline for trimethylbenzene (TMB) which was used as a surrogate for comparing air concentrations.

The concentration of VOCs measured on the day of the survey did not represent a health hazard. However, the concentration of total VOCs were in the range which may cause occupants to experience symptoms of eye nose and throat irritation. Recommendations to prevent elevated levels of VOC following future renovation efforts are provided.

KEYWORDS: SIC 1542 (Building repairs, nonresidential-general contractors), mastic remover, mastic, VOCs, volatile organic compounds, floor tile, asbestos

INTRODUCTION

On April 9, 1991, NIOSH received a request for technical assistance from the Bureau of Occupational and Industrial Safety in Harrisburg, Pennsylvania. The request was made in response to community concerns that the source of an odor at Sporting Hill Elementary was causing health problems for building occupants. The symptoms reported by staff and students included headaches, stomachaches, dizziness, and respiratory problems. The suspected sources of the odor were chemical products used during renovation of the school; specifically, a solvent used to remove tile mastic, and a carpet adhesive used during the installation of new carpet.

NIOSH conducted an industrial hygiene survey on April 31, and May 1, 1991. Air samples were collected to determine if the level of chemical air contaminants inside of the building presented a health hazard. A letter summarizing the results of the samples was sent to the Director of the Bureau on July 15, 1991. This letter reported that the air concentrations of chemical contaminants were very low, and that there was no information at that time which warranted continued closure of the school.

BACKGROUND

The Sporting Hill Elementary Building is a one story structure located in Mechanicsburg, Pennsylvania. Approximately 535 students attend the school. There are 46 staff members consisting of teachers, teachers aids, and administrative, janitorial, and food preparation personnel.

As part of an asbestos abatement program, asbestos-containing acoustical plaster ceiling, exterior duct insulation, and vinyl floor tile were removed from schoolrooms between July 3, 1990 and August 17, 1990. Areas where asbestos-containing materials were removed are shown in Figure 1. Following the removal of the tile, an organic solvent was used in these areas to remove the tile adhesive or "mastic." Carpet was installed in the schoolrooms during the next two weeks.

Upon returning to school in September, occupants complained of a strong odor in the building, and reportedly began to experience health symptoms. These symptoms included headaches, stomachaches, dizziness and respiratory problems. Areas where the occupants noticed the odor most are noted in Figure 1.

In October 1990, personnel from the Cumberland Valley School District (CVSD) attempted to mask the odor using several products, but were unsuccessful. Later that month, a consulting firm was contracted to determine if the source of the odor presented a health hazard. The consulting firm collected air samples rooms B, D, F, and H (see Figure 1); the concentrations of total hydrocarbons from these samples as n-hexane were 7, 11, 7, and 4 milligrams per cubic meter (mg/m^3) respectively. The firm noted that these levels are well below occupational guidelines, but pointed out that some individuals may be hypersensitive to chemicals at low levels. The firm recommended the use of large fans to increase the general ventilation of the area.

Because of the continued complaints of odor and health symptoms, the carpets were removed from two rooms (D and F) where the complaints were reported to be the worst. A sealant was applied to the concrete floor in room D. The use of the sealant apparently met with temporary success, however representatives of the school district reported that the odor later returned.

At the time of the NIOSH survey, the school had been closed for approximately one week because of the health concerns shared by staff and parents. The entrance into the hallway of the second and third grade wing had recently been sealed off with plastic, in an attempt to reduce contamination of the remainder of the building. The cafeteria was also sealed off, as it was being used as a decontamination room for papers and other materials which were thought to be emitting odors.

METHODS

Air samples were collected for qualitative and quantitative analysis of volatile organic compounds (VOCs). Area air samples were collected inside of the school at ten locations, and one sample was collected outside. Sample air was drawn through charcoal tubes at a flow rate of 200 cubic centimeters per minute (cc/min) using battery operated pumps; the location and air volume of each sample is provided in Table 1. The charcoal tubes were analyzed for organic compounds using gas chromatography (NIOSH Method 1501).¹ Qualitative analysis of two air samples, and one bulk sample of the mastic remover, indicated that the source of the VOCs measured in the building was the mastic remover. The VOCs detected in the two air samples were subsequently quantified for the remaining samples using the mastic remover as a standard.

EVALUATION CRITERIA

General

As a guide to the evaluation of the hazards posed by work place 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 if 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 a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other work place exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled to the level set by the evaluation criterion. These combined effects are not often considered by 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 work place are: 1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) Permissible Exposure Limits (PELs). The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits, 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 those levels specified by an OSHA PEL.

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 where there are recognized toxic effects from high, short-term exposures.

Mastic Remover

Occupational exposure guidelines do not currently exist for the mixture of compounds comprising the mastic remover. The primary constituents detected during analysis of the bulk sample, were aromatic hydrocarbons in the C₁₀ to C₁₁ range. This includes isomers of tetramethylbenzene and pentamethylbenzene. Exposure guidelines do not exist for these compounds; however, it has been suggested that the exposure guideline for trimethylbenzene (TMB), a compound of similar chemical structure but lower molecular weight, may be an appropriate surrogate for tetramethylbenzene based on toxicity data.²

The evaluation criteria for TMB is based primarily on a study of workers exposed to a mixture of isomers of TMB. The NIOSH REL, OSHA PEL, and ACGIH TLV for TMB is 125 mg/m³. This guideline is intended to prevent workers from experiencing asthmatic bronchitis, as well as a number of CNS symptoms, including nervousness and anxiety.³

VOCs in non-industrial settings

The concentrations of VOCs measured in schools and other non-industrial settings are generally much lower than those in industrial settings. Despite the low concentrations, many researchers believe that the presence of VOCs can contribute to the health symptoms experienced by workers in non-industrial settings.

Suggested explanations for this are provided by Girman.⁴ Among these explanations is that the range in age and health status can be much greater in these settings than in the industrial workplace. Also, the exposures in the industrial workplace may be limited to a few compounds, whereas in some indoor environments, there can be exposure to low concentrations of many compounds. It is unclear how to best evaluate the exposure of individuals to mixtures of VOCs at low levels.

<u>VOC Concentration (mg/m³)</u>	<u>Health Effects Expected</u>
< 0.16	None
0.16 - 3	Irritation and discomfort possible if other exposures interact
3 - 25	Irritation and discomfort probable; headache possible if other exposures interact
> 25	Additional neurotoxic

One approach to evaluating the exposure to mixtures of VOCs present in the environment, is to measure the total VOC fraction. Although established evaluation criteria for total VOCs do not currently exist, Molhave has proposed the guidelines included in the table at right (from Table V of Molhave).⁵

Molhave's guidelines are based primarily on data from laboratory studies.⁶ In these studies, test subjects were exposed to controlled concentrations of a VOC mixture consisting of 22 air pollutants normally found in Danish homes; the total VOC concentrations ranged from 5 to 25 mg/m³. Irritation symptoms refer to eye, nose, and upper respiratory tract irritation.

RESULTS

A comparison of the analysis patterns of the bulk sample of mastic remover, and the air samples indicates that the mastic remover was the principle source of the VOCs measured in the building air. The VOCs measured were a mixture of higher molecular weight aromatic hydrocarbons, mostly in the C₁₀ and C₁₁ range. Table 1 summarizes the results of the area air monitoring. The concentration of total VOCs inside the building ranged from below the limit of detection (LOD), to 2.1 mg/m³; VOCs were not detected in the sample collected outside. These concentrations of total VOCs are not believed to represent a health hazard. Concentrations in all areas sampled were well below the established occupational guideline for trimethylbenzene.

DISCUSSION

This air sampling results demonstrate that constituents of the mastic remover were being emitted into the indoor environment, eight months after its application. The total VOC concentrations measured in eight of the ten rooms were in the range (0.16- 3 mg/m³) which are suspected to be a contributory cause of irritation and discomfort. It is prudent to reduce exposures to minimize irritation symptoms and odor complaints.

The remediation measures taken at Sporting Hill Elementary included increased ventilation, masking the odor with deodorizers, and the use of a floor sealant. Ventilation of the building with outside air is an effective method of diluting contaminant levels inside provided the outside air is free of contaminants. Because of the potential for contaminating the porous surfaces which line the heating, ventilation, and air conditioning system (HVAC), and to prevent the distribution of contaminants in the building, it is recommended that HVAC systems not be operated during remedial efforts. If this is the only method of ventilating the area, porous surfaces lining the HVAC system should be protected by using a vapor barrier.

The masking of odors with the use of deodorizers or "odor counteractants" is generally not recommended. These products can emit additional VOCs, which may aggravate symptoms.

The floor sealant applied in room D was used in an attempt to prevent contaminants from being emitted into the room. If the sealant is an effective vapor barrier, it essentially "traps" the vapors in the floor, which may result in vapors migrating to other areas of the building. As a general rule, contaminated materials should be cleaned if possible, or replaced.

A potential problem specific to applying liquid products to floor surfaces, is the pooling of the liquid in floor joints and on top of damp-proof membranes. Damp-proof membranes are included in the floor's structure to prevent water and water vapor from entering into the occupied zone from below. If liquid products are used during renovation, they are likely to pool above this membrane, creating a source of contamination. If a damp-proof membrane is not in place, the excess liquids may penetrate into the soil below the floor, where depending on the chemical and soil interactions, may or may not act as a source of contamination for the occupied zone. Steps to prevent the contamination of surfaces are needed in the planning of the abatement project. It may be prudent for school districts to request evidence that such steps have been included in the work plan before giving approval for work to begin.

A plan for evaluating elevated concentrations of VOCs may include the monitoring of VOC

concentrations before, during, and following renovation efforts. A comparison of air monitoring data before and after renovation could aid in assuring that VOC concentrations are not elevated, or identify contaminated areas that need to be cleaned up before the area is reoccupied.

Assigning the responsibility of preventing elevated levels of VOCs to the contractor may help reduce their occurrence following renovation efforts. Air monitoring should be conducted by an independent contractor or consultant. If environmental monitoring is conducted for VOCs, the post-renovation samples should be collected after clean-up operations have ceased and building operations have returned to normal.

RECOMMENDATIONS

The following recommendations are provided to help prevent odor and health complaints from occurring in the future as a result of the use of chemicals to remove floor tile mastic.

1. A plan to prevent elevated concentrations of VOCs following the use of mastic remover should be contractually specified. This should include prevention efforts such as inspecting the work area to identify potential problem areas which could act as sinks for liquid contaminants, ventilating the work area during the use of VOC products, and the removal of materials with porous surfaces from the work area.
2. Environmental monitoring should be conducted by an independent consultant to evaluate VOC concentrations before and after mastic removal.
3. The work area should be enclosed during mastic removal, and exhaust ventilation provided to prevent contamination of other areas in the building.
4. Remedial efforts for reducing elevated VOC concentrations should focus on ventilation of the contaminated area with outside air. The addition of heat to the building to promote the vaporization of VOCs, often referred to as "bake-out", may also be of use. This procedure should be supervised by individuals familiar with the process, in order to provide the most effective use of temperatures and ventilation, and prevent property damage.⁴

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- 2) Representative of the Cumberland Valley School District
- 3) Representative of the Cumberland Valley Education Association

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Table 1

Results of Air Sampling for Volatile Organic Compounds (VOCs)
 Sporting Hill Elementary
 HETA 91-191
 May 1, 1991

Sample location	sample volume (liters)	mg/m ³ total VOCs
room 3	60	(0.2)
reading room	60	1.1
library	60	(0.2)
room D	64	1.8
room E	63	2.1
room F	62	0.9
crawl space below room F	61	1.4
room H	63	1.0
room L	65	ND
room R	64	ND
outside, near air inlet for room D	61	ND
limit of detection		0.05
limit of quantitation		0.2
NIOSH REL		125*
OSHA PEL		125*
ACGIH TLV		125*

ND The concentration of the sample was below the limit of detection (LOD).

() The concentration of the sample is between the limit of detection (LOD) and the limit of quantitation (LOQ). The values for the LOD and LOQ provided in the table are for a 60 liter sample.

* The principle VOCs measured were aromatic hydrocarbons mostly in the C₁₀ to C₁₁ range. This includes isomers of tetramethylbenzene and pentamethylbenzene. Evaluation criteria do not exist for these compounds, therefore the criteria for trimethylbenzene was used as a surrogate.

Sporting Hill Elementary
HETA 91-191

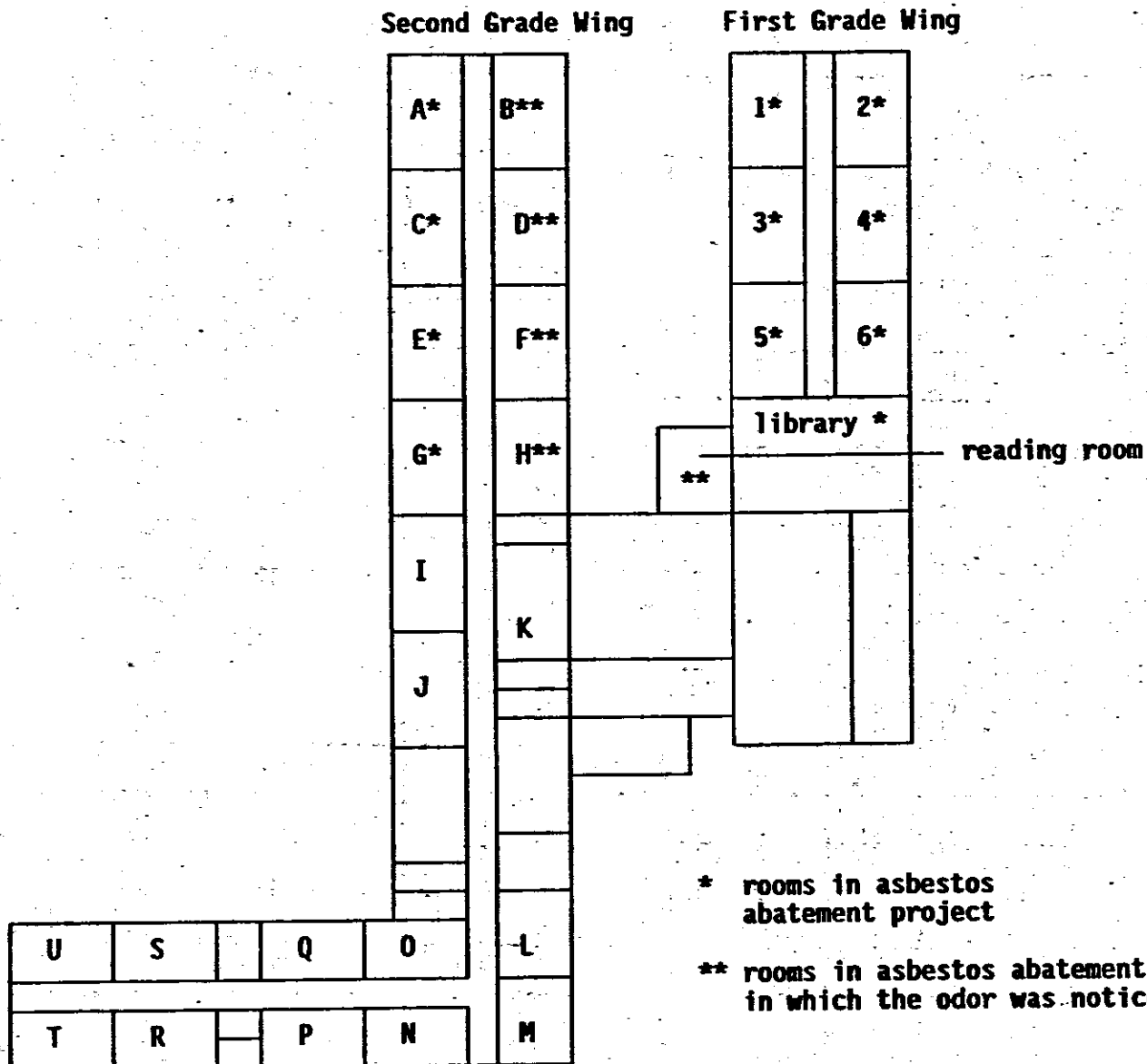


Figure 1: Sporting Hill Elementary



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