HETA 96–0188–2605
Greater Wheaton Chamber of Commerce
Wheaton, Illinois

Gregory A. Burr, CIH

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 and 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. Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Gregory Burr of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing by Ellen Blythe.

Copies of this report have been sent to employees at the Greater Wheaton Chamber of Commerce, the DuPage County Health Department, the City of Wheaton Building and Code Enforcement Office, the building owner and ventilation contractor, and to the OSHA Regional Office in Chicago, Illinois. This report is not copyrighted and may be freely reproduced. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self–addressed mailing label along with your written request to:

NIOSH Publications Office
4676 Columbia Parkway
Cincinnati, Ohio 45226
800–356–4674

After this time, copies may be purchased from the National Technical Information Service (NTIS) at 5825 Port Royal Road, Springfield, Virginia 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

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.

Health Hazard Evaluation Report 96–0188-2605
Greater Wheaton Chamber of Commerce
Wheaton, Illinois
October 1996

Gregory A. Burr, CIH

SUMMARY

On August 21–22, 1996, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at the offices of the Greater Wheaton Chamber of Commerce (GWCC), Wheaton, Illinois. The request, submitted by the manager of the GWCC office, concerned a variety of health effects, such as sinus inflammation, nausea, dizziness, and hematuria (blood in the urine), which employees believed were associated with their office environment. Several GWCC workers were also concerned about possible exposure to solvents discovered in a floor drain in a garage/warehouse area of an adjacent building.

A NIOSH investigation was conducted in August 1996 following improvements to the GWCC ventilation system. This survey also coincided with a planned "bake–out" of these offices which had been recommended by DuPage County Health Department. The bake–out consisted of turning on the heating system to accelerate the off–gassing of any volatile organic compounds (VOCs) which may have been present in the GWCC offices. Air samples for VOCs were collected both during and after the bake–out, the GWCC ventilation system was evaluated, and (although not related to the original HHE request) two bulk samples of plaster and other loose material were collected from the basement of the GWCC offices and analyzed for asbestos.

Based on a thermal desorption analysis of air samples which qualitatively scanned for a wide variety of VOCs, the following organic compounds were selected for quantitation: toluene, xylene, 1,1,1–trichloroethane, and perchloroethylene. Concentrations of these compounds were very low, ranging from trace amounts (<0.016 parts per million [ppm]) to 0.046 ppm, and were similar over both sampling days (during and after the office bake–out). Concentrations of total VOCs (TVOCs, measured as Stoddard solvent) ranged from 1.4 to 3.2 milligrams per cubic meter (mg/m^3). These TVOC concentrations are comparable to those measured in surveys of other non–industrial work settings. No odors were detected in the GWCC offices while these air samples were being collected. There was no evidence at this time for any occupational exposures at this work site which would account for hematuria among these employees.

A newly installed ventilation system was supplying approximately 100 cubic feet per minute of outside air (CFM of OA) to the office. Using an occupancy load based on the number of current GWCC employees (four), this amount of outside air exceeds the current American Society of Heating, Refrigerating, and Air–Conditioning Engineers (ASHRAE) criterion of 20 CFM of OA per occupant ($100 \div 4 = 25$ CFM of OA per occupant). No asbestos was present in the bulk samples of plaster and loose debris collected from the basement.

This NIOSH investigation did not identify any specific agents responsible for the reported symptoms. The VOC concentrations measured in the GWCC offices are similar to those reported in other non–industrial work settings and do not suggest that there is an ongoing exposure problem to these organic compounds.

Keywords: SIC 8611 (Chamber of Commerce) indoor environmental quality, IEQ, indoor air quality, ventilation, solvents, hematuria, toluene, xylene, TVOC, volatile organic compounds

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND

The Greater Wheaton Chamber of Commerce (GWCC) occupies about 1600 square feet of the first floor of a two–story brick building located in downtown Wheaton, Illinois. A private apartment is located on the second floor and a partially finished basement is beneath most of the GWCC offices. This approximately 90–year old building adjoins another single–story brick building which houses a dog grooming shop, a pet shop, a dance studio, and a warehouse/storage space (the warehouse/storage space was not in use during this survey). A diagram of the GWCC offices and surrounding companies is provided in Figure 1.

Beginning in the spring of 1996, all four GWCC employees began noticing unusual odors (described by some as medicinal or like alcohol) in the office. Coinciding with these odors, the employees also began experiencing health effects, such as headache, dizziness, nausea, sore throat, lethargy, and hematuria (blood in urine) which they perceived to be work–related. One source of these odors was presumed to be materials (roofing caulks and adhesives) used by a roofing company located in a neighboring warehouse space.[a] Of particular concern to GWCC employees was a liquid in a floor drain in a garage/warehouse area of an adjacent building which, following testing by the Wheaton Sanitary District, was found to contain the following organic compounds: toluene, benzene, ethyl benzene, and xylene.[b] In May 1996 the manager of the GWCC submitted a request for a health hazard evaluation (HHE) to the National Institute for Occupational Safety and Health (NIOSH). The initial NIOSH response to this request was to discuss the nature of the indoor environmental quality (IEQ) problems by phone and to provide the GWCC with technical information specific to their IEQ problems that would be helpful in their decision–making processes.

In June 1996, in response to these employee concerns, a representative from the DuPage County Health Department surveyed the GWCC offices, measuring carbon dioxide (CO_2) and carbon monoxide (CO), and visually evaluating the ventilation system. Carbon dioxide concentrations ranged up to 1,400 parts per million (ppm) during the workday, suggesting that an inadequate amount of outside air was being provided to the GWCC offices. (The use of CO_2 monitoring as a screening technique to evaluate whether adequate quantities of outside air are being introduced into an occupied space is discussed in more detail later in this report.) Carbon monoxide was not detected above typical background concentrations (2 to 3 ppm). The assessment by the DuPage County Health Department of the ventilation system included the following observations:

- not enough outside air was provided to the GWCC offices,
- the air–conditioning (AC) unit in the GWCC offices was a 100% recirculating system, and
- the AC system was leaking water from an improperly drained condensate pan onto the suspended ceiling tiles in the GWCC offices, creating a situation conducive for microbiological growth.

Following the survey by the DuPage County Health Department, the GWCC employees elected in June 1996 to move to another downtown office, with no intention of returning to their original location. Since the GWCC office was relocating, no further NIOSH involvement was expected by the GWCC employees.

NIOSH investigators learned in subsequent phone conversations beginning in July 1996 that GWCC employees might return to their original office location following changes in the ventilation system

[a] The roofing company had vacated this rented space prior to the NIOSH survey.

[b] The building owner arranged for this floor drain to be emptied by a local hazardous waste company prior to the NIOSH Survey.

and cleaning of the floor drain, which was a suspected source of solvents. Based on this new information, NIOSH investigators decided to conduct a site visit in August 1996 following completion of the ventilation changes. This survey would also coincide with a "bake–out" of the GWCC offices which had been recommended by the DuPage County Health Department. This bake–out consisted of turning on the heating system to accelerate the off–gassing of any volatile organic compounds (VOCs) which may have been present in the GWCC offices. Air samples for VOCs were collected on August 21, 1996 (during the bake–out, when only the heating system was operating) and on August 22 (after the heating system was turned off and the AC and outside air ventilation systems had operated overnight to ventilate the office space). In addition to collecting air samples, the GWCC ventilation system was visually evaluated and air flow measurements were made using an TSI® Model 8370 Accubalance™ air flow measuring hood. Finally, although not related to the original HHE request, two bulk samples of plaster and other loose material were collected from the basement of the GWCC offices and analyzed for asbestos.

GWCC VENTILATION SYSTEM

The ventilation system for the GWCC offices at the time of the odor episodes consisted of a perimeter hot–water baseboard heating system and a ducted AC system located in the ceiling plenum (the space above the suspended ceiling, but below the second floor of the building). With this arrangement there was no provision for outside air to be introduced into the GWCC offices during either the heating or cooling season.[c] The AC unit, equipped with low efficiency fiberglass panel filters, was designed for 100% recirculation. The boilers which provided the hot water for the perimeter heating system were located in an adjacent building.

Following the IEQ problems which lead to the temporary relocation of the GWCC employees prior to the NIOSH evaluation, the following changes were made to the ventilation system by the owner of the building.

- A Honeywell HR200 Perfect Window™ outside air ventilation system was connected to the AC system. This system is designed to provide outside air with energy savings by transferring heat between the exhaust and outside air streams. The model installed at the GWCC was designed to provide up to 150 cubic feet of outside air per minute and could function with or without the AC system operating.

- The AC supply ducts were cleaned by a commercial duct cleaning service and then treated with a biocide. According to the building owner and the cleaning service, the ducts were relatively clean and free of visible microbial contamination prior to this cleaning.

METHODS

Volatile Organic Compounds

Since concentrations of VOCs in non–industrial settings are typically low, Carbotrap® 300 stainless steel thermal desorption (TD) tubes, configured for the Tekmar® 5010 thermal desorber system, were used to collect air samples within the GWCC office and outside the building (to measure background concentrations). Each TD tube contained three beds of sorbent materials: (1) a front layer of Carbotrap C; (2) a middle layer of Carbotrap; and (3) a back section of Carbosieve S–III. Using an air sampling flow rate of 50 milliLiters per minute (mL/min), a total sample volume of 8.4 Liters was obtained. The samples were then analyzed using the Tekmar thermal desorber interfaced directly to a gas chromatograph and a mass selective detector. Each sample tube was desorbed at 400^{N}C for ten minutes. Known concentrations of several common solvents

[c] In older buildings, outside air can be introduced through cracks in the structure and through leaks around windows and doors.

were prepared and analyzed along with this sample set to estimate concentrations.

The extremely sensitive TD method can identify VOCs in the parts per billion range but does not indicate the quantity of these chemicals. To quantitate the airborne levels of the VOCs, air samples were collected at three office locations using activated charcoal as the sorbent material. For the samples collected in the GWCC offices, an air sampling flow rate of 200 mL/min was used to obtain a total sample volume of 48 Liters.[d] After reviewing the qualitative TD results, the charcoal tube air samples were analyzed for toluene, xylene (all isomers), 1,1,1–trichloroethane, perchloroethylene, and total VOCs (TVOCs, measured as Stoddard solvent) using a combination of NIOSH Sampling and Analytical Methods Nos. 1003, 1550 and 1501.[1]

EVALUATION CRITERIA: IEQ

Indoor environmental quality is affected by the interaction of a complex set of factors which are constantly changing. Four elements involved in the development of IEQ problems are:

- sources of odors or contaminants,
- problems with the design or operation of the heating, ventilation, and air–conditioning (HVAC) system,
- pathways between contaminant sources and the location of complaints, and
- the activities of building occupants.

A basic understanding of these factors is critical to preventing, investigating, and resolving IEQ problems.

The symptoms and health complaints reported to NIOSH by non–industrial building occupants have been diverse and usually not indicative of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats and other respiratory irritations. Usually, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building–related occupant complaints.[2,3] Among these factors are imprecisely defined characteristics of HVAC systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise.[4,5,6,7] Reports are not conclusive as to whether increases of outdoor air above currently recommended amounts ($\geq$15 cubic feet per minute of outside air per person [CFM OA/person]) are beneficial.[7] However, rates lower than these amounts appear to increase the rates of complaints and symptoms in some studies.[8] Design, maintenance, and operation of HVAC systems are critical to their proper functioning and provision of healthy and thermally comfortable indoor environments. Indoor environmental pollutants can arise from either outdoor or indoor sources.[9]

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related to the occurrence of symptoms than the measurement of any indoor contaminant or condition.[10] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[11,12] Less often, an illness may be found to be specifically

[d] One area air sample was collected in a business adjacent to the GWCC offices. A total air sample volume of 25 Liters was obtained at this location.

related to something in the building environment. Some examples of potentially building–related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, CO poisoning, and reaction to boiler corrosion inhibitors.

Problems that NIOSH investigators have found in the non–industrial indoor environment have included poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from office furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and RH conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job–related psychosocial stressors. In most cases, however, no cause of the reported health effects could be determined.

Standards specifically for the non–industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures.[13,14,15] With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. American Society of Heating, Refrigerating, and Air–Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines.[16,17] The ACGIH has also developed a manual of guidelines for approaching investigations of building–related symptoms that might be caused by airborne living organisms or their effluents.[18]

Measurement of indoor environmental contaminants has rarely proved to be helpful, in the general case, in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proved relationship between a contaminant and a building–related illness. However, measuring ventilation and comfort indicators such as carbon dioxide (CO_2), temperature, and relative humidity (RH) is useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath and, if monitored, can be used as a screening technique to evaluate whether adequate quantities of outside air are being introduced into an occupied space. In ASHRAE's most recently published ventilation standard, 62–1989, Ventilation for Acceptable Indoor Air Quality, a supply rate of 20 CFM OA/person for office spaces is recommended.[17]

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300–350 ppm). Carbon dioxide concentration is used as an indicator of the adequacy of outside air supplied to occupied areas. When indoor CO_2 concentrations exceed 800 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected and other indoor contaminants may also be increased.[19]

Note: No CO_2 measurements were made during this survey since the GWCC offices were not occupied.

Temperature and Relative Humidity

Temperature and RH measurements are often collected as part of an indoor environmental quality investigation because these parameters affect the perception of comfort in an indoor environment. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature.[16] Heat transfer from the body to the

environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The American National Standards Institute (ANSI)/ASHRAE Standard 55–1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable.[16] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68–74°F in the winter, and from 73–79°F in the summer. In separate documents, ASHRAE also recommends that RH be maintained between 30 and 60% RH.[16,17]

Note: No temperature and RH measurements were made during this evaluation since the GWCC offices were unoccupied and the heating and AC systems were not in normal use.

Volatile Organic Compounds

Volatile organic compounds (VOCs) describe a large class of chemicals which are organic (i.e., containing carbon) and have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. These compounds are emitted in varying concentrations from numerous indoor sources including, but not limited to, carpeting, fabrics, adhesives, solvents, paints, cleaners, waxes, cigarettes, and combustion sources. Many VOCs (i.e. toluene; xylene; 1,1,1–trichloroethane) are irritants of the eyes, mucous membranes, and upper respiratory tract. In addition, in concentrations much higher than those measured in this survey they can cause acute and chronic neurotoxic health effects.[20] Acute neurotoxic effects may include headache, lightheadedness, dizziness, weakness, poor concentration incoordination, impaired balance, confusion, drowsiness and loss of consciousness, and respiratory depression. Peripheral neuropathies and chronic central nervous system disorders (organic affective syndrome and mild chronic toxic encephalopathy) have been reported among solvent–exposed workers.

Toluene

Toluene is a colorless, aromatic organic liquid. It is a typical solvent found in paints and other coatings, and used as a raw material in the synthesis of organic chemicals, dyes, detergents, and pharmaceuticals. A previous NIOSH evaluation found the toluene content of gasoline ranging from 2.4% to 12%, with exposure levels to those involved in automobile refueling ranging from none detected to 0.56 ppm.[21]

Inhalation and skin absorption are the major occupational routes of entry. Toluene can cause acute irritation of the eyes, respiratory tract, and skin and repeated or prolonged skin contact will remove the natural lipids from the skin which can cause drying, fissuring, and dermatitis.[22] All of these effects, however, would be at concentrations higher than those measured in this survey.

Effects reported with excessive (inhalation) exposure to toluene are central nervous system (CNS) depression and neurotoxicity.[20] Studies have shown that subjects exposed to 100 ppm of toluene for six hours complained of eye and nose irritation, and in some cases, headache, dizziness, and a feeling of intoxication (narcosis).[23,24,25] No symptoms, however, were noted below 100 ppm in these studies.

Xylene

Similar to toluene, xylene is also a colorless, flammable organic liquid used in paints and other coatings, as a raw material in the synthesis of organic chemicals, dyes, and pharmaceuticals, and it is an ingredient of gasoline and many petroleum solvents.[14] The vapor of xylene has irritant effects on the skin and mucous membranes, including the eyes and respiratory tract. This irritation may cause itching, redness, inflammation, and discomfort. Repeated or prolonged skin contact may cause erythema, drying, and defatting which may lead to the formation of vesicles. Repeated exposures may cause reversible damage to the eyes.[20]

Acute xylene inhalation exposure may cause headache, dizziness, incoordination, drowsiness, and unconsciousness.[26] Previous studies have shown that concentrations from 60 to 350 ppm may cause giddiness, anorexia, and vomiting.[19] At high concentrations, exposure to xylene has a narcotic effect on the CNS, and minor reversible effects on the liver and kidneys.[20,27]

1,1,1–Trichloroethane

This clear, non–flammable liquid is also called methyl chloroform. Oral toxicity of this solvent is low and although skin absorption can occur, it is not considered a significant exposure route.[20] Like toluene and xylene, methyl chloroform can defat the skin, causing dryness, redness, and scaling.[20] This solvent is poorly metabolized once in the body and is excreted unchanged in the expired air. In some studies involving human exposures, anesthetic effects were observed at concentrations approaching 500 ppm.[28] In a long–term study of workers exposed to concentrations, which in some situations exceeded 200 ppm, no adverse effects related to exposure were observed.[26]

Perchloroethylene

Perchloroethylene, also named tetrachloroethylene, is a non–flammable liquid whose primary function includes use as a commercial dry cleaning agent and metal degreasing.[14] Inhalation exposure to perchloroethylene concentrations much higher than those measured in this evaluation can cause CNS depression (producing symptoms of vertigo, dizziness, narcosis, incoordination, headache, and unconsciousness, if exposures are sufficient), and direct contact with the liquid may impair the mucous membranes, eyes, and skin.[14,29]

Total Volatile Organic Compounds (TVOCs)

While in some instances it may be useful to identify some of the individual chemicals which may be present (such as toluene, xylene, and 1,1,1 trichloroethane), the concept of total VOCs (TVOCs) has been used to characterize these complex VOC mixtures in an attempt to predict certain types of health effects.[30] Research suggests that the irritant potency of these TVOC mixtures can vary. The use of this TVOC indicator, however, has never been standardized. Neither NIOSH nor OSHA currently has specific exposure criteria for VOC mixtures in the non–industrial environment. Considering the difficulty in interpreting TVOC measurements, caution should be used in attempting to associate health effects (beyond nonspecific sensory irritation) with specific TVOC levels.

In this evaluation, TVOCs were quantified as Stoddard solvent, a petroleum distillate mixture. Effects from exposure to Stoddard solvent are primarily acute (such as upper respiratory irritation, nausea, headaches, and irritation of the eyes and nose), unless significant amounts of substances that have chronic toxicity are present, such as benzene or glycol ethers.[20] Epidemiologic studies have shown that exposure to Stoddard solvent (as well as to other similarly refined petroleum solvents such as mineral spirits) can cause dry throat, burning or tearing of the eyes, mild headache, dizziness, central nervous system depression, respiratory irritation, and dermatitis.[31]

RESULTS AND DISCUSSION

Volatile Organic Compounds

The results from the VOC samples collected on August 21 (while the office bake–out was underway) and again on August 22 (after the heating system was turned off and the outside air and AC system had operated overnight to cool the offices) are provided in Table 1. Concentrations of toluene, xylene, 1,1,1 trichloroethane, and perchloroethylene were similar

SUGGESTED VOC GUIDELINES

TVOC Concentration (mg/m^3)	Irritation and Discomfort	Exposure Range
<0.16	No irritation or discomfort	Comfort range
0.16 – 3	Irritation and discomfort possible *(if other exposures interact)*	
3 – 25	Irritation and discomfort probable; headache possible	Discomfort range

Source: Molhave, L [1986]. Indoor air quality in relation to sensory irritation due to VOCs. ASHRAE paper 2954.

over both sampling periods. The presence of these compounds at these levels is not unusual for a non–industrial workplace. No unusual odors were detected in the GWCC offices while these air samples were being collected.

Neither NIOSH nor the Occupational Safety and Health Administration currently has specific exposure criteria for TVOC mixtures in the non–industrial environment. Research conducted in Europe suggests that complaints by building occupants may increase when TVOC concentrations increase. The previous figure lists guidelines which some researchers have used to associate solvent–like exposures to employee discomfort or irritation.[e] The TVOC concentrations measured during this evaluation are comparable to concentrations measured in surveys of other non–industrial work settings and do not suggest that there is an ongoing exposure problem to any of these substances.[32,33]

Ventilation System

The ventilation system was visually examined on August 22, 1996, and air flow measurements were made at all accessible air supplies and returns with a calibrated flow measuring hood.[f] Both the AC and the newly installed auxiliary outside air system were operating normally. Figure 1 summarizes these air flow measurements, expressed in cubic feet of air per minute (CFM).

The differences in air volume measured from diffuser to diffuser were most likely influenced by the position of the louvers on each diffuser. On the day that these air flow measurements were made most of the diffusers had their louvers adjusted to a fully–opened position. The Honeywell HR200 Perfect Window™ ventilation system was supplying 102 CFM of outside air to the office.

A visual inspection of the ventilation system was limited due to the inaccessible location of the AC unit in the ceiling. After the office had been vacated by the GWCC employees, the building owner replaced the low efficiency panel–type fiberglass air filters in the AC unit with an electrostatic air cleaner. Although the position of the condensate pan made a visual check impossible, the pan felt dry to the touch. This is not unexpected considering that the AC system had operated less than one day prior to this inspection. An electrically operated water pump had been installed to automatically drain water from the condensate pan to prevent overflow.

Other Issues

Hematuria is defined as the presence of blood, or red blood cells, in the urine. Hematuria may be classified as microscopic hematuria (when the blood is not visible to the naked eye) or "gross hematuria" (when the blood is visible to the naked eye). There are many causes for hematuria, including diseases affecting the kidney or other parts of the genitourinary system, infections (including uncomplicated urinary tract infections), and menses in menstruating women. (The last is typically not true hematuria, but rather contamination of the urine specimen by menstrual blood.)

[e] The highly variable nature of these complex VOC mixtures can greatly affect their irritancy potential.

[f] Air flow from two ceiling diffusers could not be measured because furniture blocked the use of the ventilation flow hood.

Occupational exposures to solvents have been associated with a kidney disease termed glomerulonephritis, which may be a cause of hematuria.[34] However, occupational exposures to solvents which have been associated with effects on the kidney are usually also associated with other health effects. For example, exposure to 100 ppm of toluene has been reported to cause mucous membrane irritation, headache, and dizziness, while prolonged exposure to higher levels may cause kidney damage.[20]

Because there are many non–occupational causes of hematuria, even when occupational exposure to an agent known to cause kidney damage is documented, a thorough medical evaluation should always be conducted to evaluate non–occupational causes.

CONCLUSIONS

P The low concentrations of toluene, xylene, 1,1,1 trichloroethane, perchloroethylene, and TVOCs (as Stoddard solvent) measured at the GWCC during this evaluation are similar to concentrations reported in other non–industrial work settings and do not suggest that there is an ongoing exposure problem to these organic compounds.

P It is not possible to determine what the GWCC employees may have been exposed to prior to this NIOSH survey. It is worth noting that prior to vacating their office, the GWCC employees described the unidentified odors in their work area as medicinal or like alcohol. The odors of toluene, xylene, 1,1,1–trichloroethane, perchloroethylene, which have been described as sweet or etherish, do not fit this description.

P There is no evidence at this time for any occupational exposures at this work site which would account for hematuria among these employees. All medical conditions among these employees, including hematuria, should be evaluated by the employees' physicians.

P Air flow measurements did not suggest any problems with air distribution in office areas. The Honeywell HR200 Perfect Window™ ventilation system was supplying 102 CFM of outside air. Using an occupancy load based on the number of current GWCC employees (four), this outside air system exceeds the current ASHRAE criterion of 20 CFM of OA per occupant.

P The removal of water from the AC system's condensate pan has been improved by the installation of a water pump which automatically drains the pan directly outside the building. This arrangement should reduce standing water in the condensate pan and eliminate overflow problems created by poor drainage, thus reducing the potential for microbial growth.

P No asbestos was present in the bulk samples of plaster and loose debris collected from the basement.

RECOMMENDATIONS

P The outside air intake for the Honeywell HR200 Perfect Window™ ventilation system on the east wall of the GWCC building (approximately nine feet above the ground) was adjacent to the exhaust air vent from the Honeywell system. The outside air intake should be relocated to increase the separation between the intake and exhaust vents, thus minimizing the possible reintrainment of air into the building. *(Note: These vents were scheduled to be relocated immediately following this evaluation.)*

P Because of the building design, it was not possible in this investigation to confirm that the bathroom exhaust vent extends outside the building. The company responsible for building maintenance should confirm that this exhaust does not terminate in the plenum space above the suspended ceiling.

REFERENCES

1. NIOSH [1994]. Eller PM, ed. NIOSH manual of analytical methods. 4th rev. ed. Cincinnati, OH: U.S. Department of Health and

Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–113.

2. Kreiss K [1989]. The epidemiology of building–related complaints and illness. Occupational Medicine: State of the Art Reviews 4(4):575–592.

3. Norbäck D, Michel I, Widstrom J [1990]. Indoor air quality and personal factors related to the sick building syndrome. Scan J Work Environ Health 16:121–128.

4. Morey PR, Shattuck DE [1989]. Role of ventilation in the causation of building–associated illnesses. Occupational Medicine: State of the Art Reviews 4(4):625–642.

5. Molhave L, Bach B, Pedersen OF [1986]. Human reactions to low concentrations of volatile organic compounds. Environ Int 12:167–176.

6. Burge HA [1989]. Indoor air and infectious disease. Occupational Medicine: State of the Art Reviews 4(4):713–722.

7. Nagda NI, Koontz MD, Albrecht RJ [1991]. Effect of ventilation rate in a health building. In: Geshwiler M, Montgomery L, and Moran M, eds. Healthy buildings. Proceedings of the ASHRAE/ICBRSD conference IAQ'91. Atlanta, GA: The American Society of Heating, Refrigerating, and Air–Conditioning Engineers, Inc.

8. Jaakkola JJK, Heinonen OP, Seppänen O [1991]. Mechanical ventilation in office buildings and the sick building syndrome. An experimental and epidemiological study. Indoor Air 1(2):111–121.

9. Levin H [1989]. Building materials and indoor air quality. Occupational Medicine: State of the Art Reviews 4(4):667–694.

10. NIOSH [1991]. Hazard evaluation and technical assistance report: Library of Congress, Washington. D.C. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 88–364–2104.

11. Boxer PA [1990]. Indoor air quality: a psychosocial perspective. JOM 32(5):425–428.

12. Baker DB [1989]. Social and organizational factors in office building–associated illness. Occupational Medicine: State of the Art Reviews 4(4):607–624.

13. CDC [1988]. NIOSH recommendations for occupational safety and health standards 1988. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. MMWR 37 (supplement S–7).

14. 54 Federal Register 35338 [1993]. Occupational Safety and Health Administration: air contaminants; final rule. To be codified at 29 Code of Federal Regulations, Part 1910. Washington, DC: U.S. Government Printing Office.

15. ACGIH [1996]. Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

16. ASHRAE [1981]. Thermal environmental conditions for human occupancy. American National Standards Institute/ASHRAE standard 55–1981. Atlanta, GA: American Society for Heating, Refrigerating, and Air–Conditioning Engineers, Inc.

17. ASHRAE [1989]. Ventilation for acceptable indoor air quality, standard 62–1989. Atlanta, GA: American Society of Heating, Refrigerating, and Air–Conditioning Engineers, Inc.

18. ACGIH [1989]. Guidelines for the assessment of bioaerosols in the indoor environment. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

19. 59 Federal Register 15968 [1994]. Occupational Safety and Health Administration: indoor air quality; proposed rule. To be codified at 29 Code of Federal Regulations, Parts 1910, 1915, 1926, and 1928. Washington, DC: U.S. Government Printing Office.

20. Hathaway, GJ, Proctor NH, Hughes JP, Fischman ML [1991]. Chemical hazards of the workplace. 3rd ed. Philadelphia, PA: Van Nostrand Reinhold.

21. NIOSH [1992]. Health hazard evaluation report: American Petroleum Institute, Washington, D.C. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH Report No. 88–304–2326.

22. NIOSH [1973]. Criteria for a recommended standard: occupational exposure to toluene. Cincinnati, OH: U.S. Department of Health, education, and Welfare, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 73–11023.

23. WHO [1981]. Recommended health–based limits in occupational exposure to select organic solvents. Geneva: World Health Organization, Technical Report Series No. 664.

24. Benignus VA [1981]. Health effects of toluene: a review. Neurotoxicology *2*:567–568.

25. Anderson I, et al. [1983]. Human response to controlled levels of toluene in six–hour exposures. Scand J Work Environ Health 9:405–418.

26. NIOSH [1975]. Criteria for a recommended standard: occupational exposure to Xylene. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75–168.

27. NIOSH [1977]. Occupational diseases: a guide to their recognition. Cincinnati, OH: National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77–181.

28. ACGIH [1991]. Documentation of the threshold limit values for chemical substances and physical agents and biological exposure indices, 6th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

29. NIOSH [1976]. Criteria for a recommended standard: occupational exposure to Perchloroethylene. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76–185.

30. Molhave L, Nielsen GD [1992]. Interpretation and limitations of the concept "Total Volatile Organic Compounds" (TVOC) as an indicator of human responses to exposures of volatile organic compounds (VOC) in indoor air. Indoor Air, Vol. 2, pp. 65–77.

31. NIOSH [1977b]. Criteria for a recommended standard: occupational exposure to refined petroleum solvents. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77–192.

32. Hansen DL [1995]. Volatile organic compounds in non–industrial settings–an overview of sources and concentrations. Presented in Professional Development Course

No. 21 on May 21, 1995, at the American Industrial Hygiene Conference and Exposition, Anaheim, CA.

33. NIOSH [1993]. Hazard evaluation and technical assistance report: Pennsylvania Department of Revenue, Harrisburg, PA. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 92–66–2318.

34. Zenz C, Dickerson OB, Horvath EP eds. [1994]. Occupational Medicine, 3rd Edition, Mosby–Year Book, Inc., Philadelphia, PA.

Table 1
Results of Air and Bulk Sampling Conducted at the Greater Wheaton Chamber of Commerce (HETA 96–0188)

Air Sampling for Selected Volatile Organic Compounds

Date	Sample Location	Sampling Period	Sample Volume (Liters)	Concentration, **ppm**				Concentration, **mg/m³**
				Toluene	Xylene	1,1,1 Trichloroethane	Perchloroethylene	TVOC (as Stoddard solvent)
8/21	Director's Office	12:20➞4:17 pm	47	0.027	0.018	0.11	0.028	3.2
8/21	Conference Room	12:20➞4:18pm	48	0.025	0.017	0.11	0.028	2.9
8/22	Director's Office	8:05 am➞12:05 pm	48	Trace	Trace	0.017	0.046	1.4
8/22	Conference Room	8:05 am➞12:05 pm	48	Trace	Trace	0.017	0.046	1.5
8/22	Canine Corners	5:50 am ➞7:55 am	25	Trace	0.032	Trace	0.13	3.0
Minimum Detectable Concentration			48	0.005	0.005	0.004	0.003	0.21
Minimum Quantifiable Concentration			48	0.019	0.016	0.013	0.01	0.73
Non–industrial concentrations reported in other studies℗				0.011‡	0.007‡	ND to 0.006 !	ND to 0.007 !	

ppm = Parts per million
mg/m³ = Milligrams per cubic meter
Trace = Between the Minimum Detectable and Minimum Quantifiable Concentrations
TVOC = Total Volatile Organic Compound
℗ = These concentrations are provided only for comparison purposes. There are no applicable NIOSH, OSHA, or ACGIH exposure criteria for non–industrial work environments.
‡ = Hansen DL [1995]. Volatile Organic Compounds in Non–Industrial Settings–An Overview of Sources and Concentrations. Professional Development Course No. 21, presented at the American Industrial Hygiene Conference and Exposition, Anaheim, CA.
! = NIOSH [1993]. Hazard evaluation and technical assistance report: Pennsylvania Department of Revenue, Harrisburg, PA. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 92–66–2318.

Bulk Sampling for Asbestos Content†

Date	Description of Bulk Sample	Asbestos Content
8/22	Loose plaster between wood laths in the basement	No chrysotile, amosite, crocidolite, actinolite, or other forms of asbestos were present in this sample.
8/22	Loose, white material from the SE basement corner	No chrysotile, amosite, crocidolite, actinolite, or other forms of asbestos were present in this sample.

† = The samples were analyzed by polarized light microscopy. Microscope slides were prepared from each sample using a 1.55 refractive index liquid and then scanned for the presence of asbestos utilizing polarized light microscopy and dispersion staining techniques. The limit of detection using this technique is <1% asbestos per sample.

Delivering on the Nation's promise:
Safety and health at work for all people
Through research and prevention