NIOSH HEALTH HAZARD EVALUATION REPORT

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West Virginia Department of Health and Human Resources - Webster Springs District Office
Webster Springs, West Virginia

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PREFACE

The Respiratory Disease Hazard Evaluations and Technical Assistance Program (RDHETAP) 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 (OSH) Act of 1970, 29 U.S.C. 669(a)(6) or Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, 30 U.S.C. 951(a)(11), which authorize the Secretary of Health and Human Services, following a written request from any employer 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.

RDHETAP also provides, upon request, technical and consultative assistance 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 NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Lisa G. Benaise, MD, MPH; Jeana M. Harrison, MS; and Terri A. Pearce, PhD of the RDHETAP, Division of Respiratory Disease Studies (DRDS). Industrial hygiene assistance was provided by Carol Y. Rao, ScD. Statistical analysis assistance was provided by Sandra White. Data entry and data cleaning was performed by Tonya Rowan. Data programming assistance was provided by Nicole Edwards. Medical data management assistance was provided by Brian Tift. Spirometry quality control assistance was provided by Diana Freeland. Spirometry data cleaning was performed by Dave Spainhour. Serial spirometry analysis assistance and valuable review were provided by Jean Cox-Ganser, PhD, Paul Enright, MD, Paul Henneberger, ScD, and Kay Kreiss, MD. Serial spirometry training and field assistance was provided by Jim Taylor, Kimberly Stemple, Dave Spainhour, and Amber Harton. Desktop publishing was performed by Terry Rooney and Amber Harton.

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.

HIGHLIGHTS OF THE NIOSH HEALTH HAZARD EVALUATION AT WEST VIRGINIA DEPARTMENT OF HEALTH AND HUMAN RESOURCES - WEBSTER SPRINGS DISTRICT OFFICE

The National Institute for Occupational Safety and Health (NIOSH) received a Health Hazard Evaluation request from the West Virginia Department of Health and Human Resources (WVDHHR) on behalf of employees in the Webster Springs, West Virginia, district office. Concerns included possible microbial contamination from recurrent water incursion, chemical smells, and other unpleasant odors. Employees reported mold growth on carpet and drywall on the first floor. Reported symptoms and conditions included asthma, respiratory difficulty, sinus infections, and allergic reactions.

What NIOSH Did

- Reviewed previous consultant environmental reports
- Conducted two building walkthroughs
- Examined the roof and the heating, ventilation, and air conditioning (HVAC) system
- Measured temperature, relative humidity, carbon dioxide, and particle counts
- Sampled air for mold and volatile organic compounds
- Reviewed employee medical records
- Administered two health questionnaires to WVDHHR employees during two site visits
- Performed objective medical tests to assess respiratory health and work-related changes in lung function

What NIOSH Found

- From the 2004 questionnaire with 24 respondents (100% participation):
  - Five employees reported current asthma diagnosed after building occupancy.
  - Twenty employees (83%) reported one or more of: wheeze, chest tightness, shortness of breath, cough, or awakened by breathing difficulty, occurring in the last 12 months; and 12 of these 20 employees reported that the symptoms improved away from work.
- Employees were 4.6 and 2.6 times more likely to report having current asthma than the U.S. adult population and the West Virginia adult population, respectively.
- Seven employees had indications of abnormal lung function or airways inflammation. One of these seven employees had serial spirometry results suggestive of a work-related pattern.
- Water incursion and visible mold were present in the basement in April 2004.

What Managers Can Do

- Disseminate the findings of this report to inform employees that a risk for respiratory effects may exist in this building.
- Maintain dry building conditions, particularly in the basement.
- Maintain HVAC systems to ensure acceptable carbon dioxide concentrations, temperature, and relative humidity levels throughout the year.
- Ensure that the restrooms remain under negative pressure in relation to the office space.

What Employees Can Do

- See a physician for treatment of lower and upper respiratory symptoms, asthma, and allergies, including symptoms that worsen when at work or get better when away from work.
- Report water incursion, mold growth, or unpleasant odors to building managers.

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2003-0300-2993

Health Hazard Evaluation Report 2003-0300-2993 West Virginia Department of Health and Human Resources - Webster Springs District Office Webster Springs, West Virginia

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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a Health Hazard Evaluation request from the West Virginia Department of Health and Human Resources (WVDHHR) Director of Facilities regarding leased office space in the Webster Springs, West Virginia, district office. The request reported poor indoor air quality, new-carpet and other odors, water leaks, and inadequate heating, ventilation, and air-conditioning systems. The request reported respiratory, allergy, and sinus symptoms; eye, nose, and throat irritation; and skin irritation, including rashes and hives, among the employees.

On September 11-12, 2003, we conducted a walkthrough of the building. Odors from cleaning supplies were apparent. We did not find obvious sources of mold or water incursion. Measurements made during the site visit found bioaerosol concentrations that were similar to outdoor concentrations, carbon dioxide concentrations that were elevated, and volatile organic compounds that are commonly found in office settings. Twenty-one (88%) of the employees completed a health questionnaire. Seven employees (33%) reported a physician diagnosis of asthma after occupying the building.

We returned to the building on April 12-16, 2004 and performed a second building walkthrough, administered health questionnaires to employees, conducted lung function testing, and offered employees serial spirometry for assessment of work-related changes in lung function.

During the 2004 walkthrough, we found water incursion, visible mold, and musty odors in the basement. Musty odors were noticeable in the entry area of the building, the elevator, and the south stairwell. It had been raining before and during the 2004 visit, but not during the 2003 visit. Odors from the restrooms were evident on the second floor.

All 24 WVDHHR employees currently working in the building participated in the April 2004 medical testing and questionnaire. The employees were 4.6 and 2.6 times more likely to report having current asthma than the U.S. adult population and the West Virginia adult population, respectively. Five employees reported current asthma that was diagnosed after building occupancy. Twelve employees reported lower respiratory symptoms occurring in the last 12 months and improving when away from the building.

Seven of the employees had some indication of abnormal lung function or exhaled nitric oxide levels suggestive of airways inflammation. Three of these seven employees had both some degree of bronchial hyperresponsiveness and exhaled nitric oxide levels suggestive of airways inflammation, consistent with poorly controlled asthma. Furthermore, one of these three employees had indications of a work-related pattern of lung function on serial spirometry.

Our survey identified respiratory symptoms and conditions among employees that may be related to the workplace. The prevalences of physician-diagnosed and current asthma were high when compared to national and state prevalences, as were building-related symptoms. The building was found to have standing water, mold, and musty odors in the basement. Odors were also present in other parts of the building. The documented health effects and the environmental findings of water damage, standing water, and mold dictate continued remediation efforts to improve the conditions in the building as a means to protect the health of occupants and to prevent additional health effects.

The NIOSH investigators determined that this building located in Webster Springs, West Virginia, was damp, as evidenced by water incursion and visible mold in the basement combined with musty odors in other areas of the building. While specific environmental exposures causing these health effects were not identified, current scientific evidence indicates that damp buildings are associated with the risk of nose and throat symptoms, cough, wheeze, asthma symptoms in sensitized persons, and hypersensitivity pneumonitis, lending credence to attributing excess employee symptoms and conditions to working in the building. The employee reports of respiratory symptoms and the objective lung function test results support the possibility of work-related respiratory conditions. NIOSH provided recommendations for correcting the dampness and conducting building maintenance to help reduce health risks for the building occupants.

Keywords: NAICS Code 624190, other individual and family services, office building, indoor air quality, indoor environmental quality, water incursion, particles, volatile organic compounds, mold, serial spirometry, exhaled nitric oxide, methacholine challenge, pulmonary function testing

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INTRODUCTION

On June 13, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a Health Hazard Evaluation request from management of the West Virginia Department of Health and Human Resources (WVDHHR) regarding the Webster Springs District Office's leased office space. Exposure concerns listed on the request included indoor air quality problems, new-carpet and other odors, water leaks, and inadequate heating, ventilation, and air-conditioning (HVAC) systems. The request reported respiratory, allergy, and sinus symptoms including shortness of breath; eye, nose, throat irritation; and skin irritation, including rashes and hives. Several employees had reportedly visited emergency rooms due to respiratory or allergy symptoms that they felt were related to working in the building.

Employees reported concerns about the receptionist office and the Social Services areas. Employees described episodes in the previous two years of foul odors and sewage spouting from a sink in the conference room near the Social Services area. Unpleasant odors in other parts of the building were reported to be worse during rainy days. Employees reported visible mold growth on the carpet and drywall in the office space on the first floor.

BACKGROUND

The two-story brick building with a below-grade basement was constructed in the late 1920s or early 1930s. Two sections were apparently added to the original building at a later time. A hardware store and department store had occupied the building for many years prior to conversion to a mixed-use building. WVDHHR rents the entire second floor from the town and are the only occupants of this floor. The first floor has a fitness center and physical therapy business, a West Virginia Department of Natural Resources (WVDNR) office, a town visitors' center, and a separate set of offices for the WVDHHR Children's Home Services, which is not affiliated with the second floor offices. The basement, consisting of concrete block walls and a concrete floor, is unoccupied. Five ventilation units, one for each zone on the second floor, are located on the building's rubber-membrane flat roof. Units for the first floor are located on the ground surrounding the building and in the basement.

Most employees who occupy space in the building work between 7:00 AM and 5:00 PM, Monday through Friday; however, the fitness center may be open longer hours. WVDHHR has 24 employees on the second floor; the fitness center averages 2-4 employees and a varying number of members at any given time, one employee works in the visitor center, and two employees work for WVDNR. WVDHHR has one employee (of the 24) who does the janitorial work, usually beginning at approximately 2:30 PM and ending by 6:00 PM.

METHODS

The NIOSH team reviewed six environmental consultant reports and written employee symptom logs sent by the facility manager. We then conducted two surveys at the building. The objective of the first survey, conducted on September 11-12, 2003, was to look for potential exposures and to document reported health effects. The objectives of the second survey, conducted from April 12-16, 2004, were to further evaluate potential exposures, conduct objective medical testing, and administer a health questionnaire.

Environmental Surveys

Details of environmental measurements by sample location for both surveys are given in Table 1. During both surveys, we conducted walkthroughs in all accessible areas of the building. Between the two surveys, these included the basement, first floor (Children's Home Services, physical therapy center/gym, WVDNR office, and visitors' center), second floor (WVDHHR offices), and roof. We also logged measurements of carbon dioxide (CO_2)

concentrations, temperature, and relative humidity using Q-Trak™ indoor air quality monitors (Model 8554, TSI Incorporated, St. Paul, MN) in 1-minute sample averaging periods for 19 hrs in September 2003 and for 29 days in April 2004. Outside measurements were made on top of the elevator service room but the comparison outdoor measurements were limited because the location was not secure for overnight sampling.

During the first survey (September 2003), we measured total airborne fungal spore levels in several rooms on the second floor and compared the concentrations indoors to the concentration we measured outdoors. Fungal spore trap samples were collected with Air-O-Cell® Cassettes (Zefon International, Incorporated, Ocala, FL) at a flow rate of 15 L/min for five minutes. Environmental Microbiological Laboratories, Inc. analyzed the samples microscopically. We sampled air according to the NIOSH Manual of Analytical Methods (Method #2549) using thermal desorption tubes and analyzing the samples for volatile organic compounds (VOCs) using gas chromatography/mass spectrometry (GC/MS).[1] We used a flow rate of 0.05 L/min and sample times ranging from 161 to 172 minutes. We conducted pressure mapping with a digital manometer (Model DG-2, The Energy Conservatory, Minneapolis, MN) and used smoke tubes to assess air movement on the second floor.

During the second survey (April 2004) we sampled suspected mold growth in the basement with Bio-Tape™ Surface Samplers (Zefon International, Incorporated, Ocala, FL), flexible microscope slides with an adhesive area for sample collection and a slide container to reduce cross-contamination. We viewed the samples under a light microscope at 400 times magnification to determine whether mold hyphae or spores were present. We sampled VOCs using fused silica-coated stainless steel canisters (Entech Instruments, Incorporated, Simi Valley, CA). These are evacuated canisters that allow room air to enter the canister via a valve at a set flow rate. We used one-liter canisters to sample at 0.04 L/min for 25 minutes in each location. The samples were analyzed using GC/MS according to the Environmental Protection Agency Method TO-15.[2] Compound concentrations were determined by comparing the sample response to that of known compounds in the calibration curve. Compounds that were not in the calibration standard were compared to the toluene response. We measured real-time particle counts (particles/m^3) with four FilterChek™ SubMicron Aerosol Spectrometer/Filter Efficiency Monitors (Model 1.108, Grimm Technologies Incorporated, Douglasville, GA), using one-minute sample averaging periods over 29 days. The instrument measured particles in a size range of 0.3 to 20 micrometers (μm) at a flow rate of 1.2 liters per minute (L/min). We analysed total particle count data from each location as well as two combined-size fractions: particles less than 1 micrometer and particles sized between 1 and 10 micrometers.

Epidemiologic Surveys

Questionnaires

In both 2003 and 2004, a health questionnaire was offered to all current workers (see Appendix B for the 2004 questionnaire). During the first survey in 2003, the NIOSH medical officer administered the questionnaire to ten employees. Additionally, eleven employees completed the questionnaire by themselves and mailed it to NIOSH. During the second survey, NIOSH employees administered a similar health questionnaire electronically. The data were exported into SAS® System for Windows (SAS version 8.02, SAS Institute, Cary, NC) for analysis.

For the 2004 questionnaire data, we compared the prevalence rates of respiratory symptoms and self-reported medical diagnoses among the WVDHHR employees to the U.S. adult prevalence rates obtained from the third National Health and Nutrition Examination Survey (NHANES III).[3] For comparisons with NHANES III, we used indirect standardization for race (white), gender (male, female), age (17 to 39 years; 40 to 69 years), and cigarette smoking status (ever smoker; never smoker).

We also compared the prevalences of ever and current asthma in the study population to prevalences in the 2003 Behavioral Risk Factor Surveillance System (BRFSS) for West Virginia.[4] For comparisons with BRFSS, we standardized for gender. We also compared the prevalences of work-related upper and lower respiratory symptoms among the WVDHHR employees with prevalences reported in a study of 41 large U.S. office buildings without reported problems, conducted from 1994-1996.[5] We derived 95% confidence intervals (CI) using a method which assumes that the observed data are from a Poisson distribution.

Medical Tests

In 2004, we offered all current employees medical tests including spirometry, methacholine challenge testing (MCT), exhaled nitric oxide, and serial spirometry.

Spirometry

Qualified technicians followed standard guidelines for spirometry.[6] We compared test results to the lower limit of normal (LLN) values from the NHANES III reference value.[7] We measured forced vital capacity (FVC), the volume of air forcefully exhaled from a maximal inspiration to a complete exhalation; and forced expiratory volume in one second (FEV_1), the volume of air exhaled in the first second of the forced expiration. The ratio between the two (FEV_1/FVC) was computed. Airways obstruction was defined as both FEV_1 and FEV_1/FVC% below the LLN. Restriction was defined as a FVC below the LLN with a normal FEV_1/FVC%.

Methacholine Challenge Test

To detect bronchial hyperresponsiveness, we performed MCT using standardized techniques with five different concentrations (0.125, 0.5, 2.0, 8.0, and 32.0 milligrams per milliliter (mg/mL)) of methacholine.[8] Five breaths of nebulized methacholine were administered for each dose, starting with 0.125 mg/mL, and spirometry was done after the fifth breath. If the highest FEV_1 after any dose was greater than 80% of the highest baseline FEV_1, the next higher concentration of methacholine was administered. If FEV_1 dropped more than 20% of the baseline value, no further methacholine was given. We reported the MCT test results as PC_{20} (the provocative concentration of methacholine that caused a 20 percent decline in FEV_1). When a decline in FEV_1 of greater than 20 percent occurred, the PC_{20} was interpolated on a dose-response graph as the concentration at which the line connecting the FEV_1 values at the penultimate and ultimate doses administrated crosses the 20% FEV_1 decline criterion. We defined bronchial hyperresponsiveness as a PC_{20} of 4.0 mg/mL or less, and borderline bronchial hyperresponsiveness as a PC_{20} between 4.1 and 16.0 mg/mL.

We asked employees who reported use of long-acting inhaled respiratory medication or medium-acting inhaled respiratory medication to refrain from using their inhaler after the morning dose on the day before spirometry testing (to achieve a 24-hour respiratory medication-free period). Participants who took short-acting respiratory medication were asked to hold medication after midnight before the day of spirometry testing (to achieve the 8-hour respiratory medication-free period recommended by the American Thoracic Society).[8]

Exhaled Nitric Oxide Test

Nitric oxide (NO) gas, produced by various cells within the respiratory tract, is detectable in the exhaled air. The fractional concentration of exhaled NO (FE_{NO}) has been used as a marker of inflammation. An association between an elevated FE_{NO} and poorly controlled asthma has been demonstrated in the literature.[9-11] Nitric oxide was measured offline using standardized techniques,[10] in which exhaled air was collected in 10-liter Mylar® gas-collection balloons (Sievers model 01410, Boulder, CO). A target backpressure of 13 cm H_2O, with the acceptable range of 10-15 cm H_2O was marked on the pressure meter. Nitric oxide was analyzed with a rapid-response chemiluminescence analyzer (Sievers model 280; Boulder, CO). We considered a measurement greater than 12 parts

per billion (ppb) as suggestive of airways inflammation.[12,13]

Serial Spirometry

We offered serial spirometry testing to all employees to determine possible work-related patterns of lung function. Employees used handheld spirometers (EasyOne™, ndd Medical Technologies, Chelmsford, MA) to conduct pulmonary function measurements and to record diary entries over a three-week period. We asked participants to do five daily sessions with at least three blows per session. The sessions were: 1) on waking (before medication, if used); 2) on arrival at work, or mid-morning on days not at work; 3) before lunch; 4) before leaving work, or before the evening meal on days not at work; and 5) at bedtime. At each session, the participant made entries in a diary programmed into the spirometer that included: time of day, location of testing, work shift, respiratory symptoms, last medication use, last tobacco use, and odors or other exposures encountered (Appendix C). We provided the participants with a supplemental, bound diary for use throughout the testing period to hand-record any respiratory events or exposures that were not entered into the spirometer, to correct a mistake, or to further explain spirometer entries. The participants cradled their spirometer on the modem every night before bedtime and spirometry results were automatically downloaded to a dedicated NIOSH computer. We compensated each participant with a gift card valued from $25 to $100 depending on the level of completion of the serial spirometry testing and the return of all equipment.

We analyzed the serial spirometry data with OASYS software (OASYS Research Group, Birmingham, UK).[14-19] This allowed a comparison between measurements at work versus away from work to assess work-related patterns of any changes in mean pulmonary function. The variability of peak flow or FEV_1 in a 24-hour period (diurnal variability) was calculated as the difference between the maximum and the minimum reading divided by the study period mean for the respective variable. We considered a peak flow diurnal variability of 20% or more and a FEV_1 diurnal variability of 15% or more as greater than normal variability.[20,21]

RESULTS

Environmental Surveys

Walkthrough Observations

Several items were identified during the 2003 walkthrough that were reported to management with recommendations for correction in Interim Letter I (Appendix D). Odors were evident in the restrooms, the adjoining hallway, and nearby office cubicles. During the evaluation, investigators noted that the restrooms were under positive pressure in relation to the hallway when the exhaust fans were not operating, allowing air to move from the restrooms into the hallway. When exhaust fans were turned on for 20 minutes, the pressure in the restrooms was neutral (not positive or negative) in relation to the hallway. This finding was identified as a potential reason that chemical odors produced by cleaning products and air fresheners were noted by many employees because employees reported routinely turning off the exhaust fan when exiting the restroom. The restrooms were also served by supply and return air vents that were part of the overall heating, ventilation, and air-conditioning (HVAC) system, which may be a pathway for these odors to travel to other areas of the building.

At the time of the 2003 walkthrough, we did not observe obvious sources of mold or water incursion in any areas of the building, but the carpet had been replaced and the walls were freshly painted. During the 2003 walkthrough, the basement appeared dry, but due to low-light, we were not able to determine whether mold was present. Employees described episodes in the previous two years of foul odors in various areas of the building that were worse on rainy days and sewage spouting from a sink in the conference room near the Social Services area. Employees described flooding that had occurred in Children's Home Services (1st floor) during

heavy rainfalls in the summer of 2003. Water reportedly flowed down the handicapped-accessible ramp and under the door. Employees reported wet carpet and black mold on the walls. When we returned to the building on April 12, 2004, we immediately noticed an obvious musty odor in the entry area of the building that persisted in the elevator and in the south stairwell. These odors were evident during the entire visit but were particularly noticeable on the rainy days, April 12-14, 2004.

Our visual inspection of the office areas found them clean and well-maintained. No indications of water staining or mold were observed on walls, ceilings, carpeting, or furnishings of the first or second floors. However, odors were evident in many areas of the second floor office space and were particularly strong in the hallway outside the restrooms and in an enclosed office on the west side of the building. These odors appeared to originate in the women's restroom. An exhaust fan was located in each bathroom ceiling and was ducted to the outside. However, exhaust flows were apparently inadequate for complete removal of odors, allowing transit of odors to other areas of the building through the above-ceiling return- air plenum.

In the basement, we found standing water, visible mold growth on some walls, and obvious musty odors. The odors appeared to be strongest near the seven open sumps. Standing water was observed in all of the sumps and on the basement floor. Only three of the sumps were equipped with pumps for water removal and only two were functioning properly. Water was entering the basement through cracks in several areas of the east wall, possibly from the parking lot and run-off from the hill where the building is located. Some items stored in the basement were placed on the floor and were wet due to standing water.

We accessed the roof and HVAC units during the site visit. The roof was found to be in good repair and appeared to be constructed in a manner that would allow rain water to drain properly. The five HVAC units were located on the roof and were made by two major manufacturers. Inspection of both types of units found that some filters were not properly installed. We found that outside make-up air-supply dampers on two of the units were in the closed position and therefore not supplying fresh air to the spaces served by those units. The building owner made corrections upon our bringing this to attention. (See Appendix E for a list of items completed by the building owner during the survey.)

Temperature, Relative Humidity, and Carbon Dioxide

In September 2003, the temperature and relative humidity in three indoor areas (backstairs, fileroom, and Social Services) ranged from 70.2 to 74.5^{o}F and 34.4 to 45.2%, respectively (Table 2). CO_2 ranged from 474 to 1095 parts per million (ppm), with averages in the 550 to 650 ppm range. In April and May 2004, the temperature and relative humidity in these areas ranged from 69.2 to 79.9^{o}F and 17.1 to 43.8%, respectively, and CO_2 concentrations ranged from 377 to 1562 ppm (Table 2). The CO_2 concentrations followed a pattern that appeared to track with building occupancy. CO_2 concentrations increased during the workday and decreased during the night, to about 500 ppm, close to the average CO_2 concentration measured outside the building (Figures 1 and 2).

Particulate

Average total particle counts ranged from 31,618,537 to 41,321,027 particles/m^3 in the same indoor areas. The outside total counts averaged 28,706,241 particles/m^3 (Table 2). Real-time counts of submicron particles (0.3 - 1 μm) tended to be lower on work days and increase on the weekends and nights (Figure 3). Counts for particles sized one to ten micrometers followed a similar pattern (Figure 4), but were two orders of magnitude lower than the submicron particle counts.

Fungi

Table 3 provides the airborne fungal spore sampling results for samples collected in several areas of the building and outdoors in September 2003. Indoor concentrations of airborne fungal

spores were less than five percent of the outdoor concentration in all areas sampled. The fungal types found indoors were similar to those collected outdoors. We verified the presence of mold hyphae and spores on tape-lift samples of apparent mold growth collected from several surfaces in the basement in April 2004.

Volatile Organic Compounds

A total of 87 different VOCs were detected across samples taken with thermal desorption tubes during the September 2003 survey (Table 4). We repeated VOC sampling during the April 2004 site visit using evacuated canisters to allow quantitative determination of compounds present (Tables 5A and B). Many of the VOCs were either not detectable or the concentration was lower than the estimated limit of quantification (1 part per billion by volume (ppb)). Many VOCs detected during both surveys were similar to types commonly found indoors and attributed to sources such as cleaning agents, copy machines, perfumes, dry-cleaned clothes, and vehicle emissions.[22]

Epidemiologic Surveys

Results from the 2003 questionnaire collected during the preliminary site visit were reported in Interim Letter II (Appendix D). These results led to the decision to return to the building in April 2004.

In April 2004, we had 100% participation (24/24) for questionnaire, spirometry, and exhaled nitric oxide. For MCT we had results for 23 of the 24 employees, because one employee had contraindications for MCT. The initial participation rate for serial spirometry was 22/24 (92%) and 18 (75%) performing serial spirometry for the entire three-week period.

Demographics for the April 2004 participants are given in Table 6. The employees were all white and primarily female (79%). Seventeen percent were current smokers and 67% were never smokers. The mean tenure working in the building was slightly more than 5 years.

Medical Diagnosis and Medication Use

Seven participants (29%) reported receiving a physician diagnosis of new-onset asthma after coming to work in the building, and five of these seven employees reported the asthma as being current (Table 7). No one reported hypersensitivity pneumonitis in April 2004 (although one employee who participated in both surveys reported diagnoses of both asthma and hypersensitivity pneumonitis in the September 2003 survey). Compared to the U.S. adult population, ever-diagnosed asthma prevalence was 4.1 (95% CI 2.1-8.1) times higher, and current asthma prevalence was 4.6 (95% CI 2.1-10.0) times higher among the building occupants than would be expected based on their age, gender, race, and smoking status. Compared to the West Virginia adult population, ever-diagnosed asthma prevalence was 2.6 (95% CI 1.3-5.1) times higher, and current asthma prevalence was 2.6 (95% CI 1.2-5.7) times higher than would be expected based on their gender. Seven participants reported asthma medication use in the past 12 months, and six of these seven also reported using nasal sprays and anti-histamine medication. Six additional participants reported using nasal sprays and anti-histamine medication.

Symptoms Occurring in the Last 12 Months

Twenty participants (83%) reported one or more of five lower respiratory symptoms (wheeze, chest tightness, shortness of breath, cough, or awakened by breathing difficulty) in the last 12 months, and 12 of these 20 employees (60%) reported that the symptoms improved away from work. Table 8 provides prevalences of specific symptoms, including those that improved away from work.

When compared to the U.S. adult population, the participants were 3.1 times more likely to report shortness of breath while hurrying or walking up a slight hill, 4.1 times more likely to report wheeze, and 1.8 times more likely to report sinusitis or sinus problems. Nasal and eye symptom prevalences were somewhat higher, but not statistically significantly different, than the U.S. adult population (Table 9).

Symptoms Occurring at Least Once Per Week in the Last Four Weeks

Fifteen participants (63%) reported one or more of five lower respiratory symptoms (wheeze, chest tightness, shortness of breath, cough, or awakened by breathing difficulty) occurring one or more times per week in the last four weeks, and 10 of these 15 employees reported that the symptoms improved away from work. In comparison to reports from U.S. office workers of symptoms occurring one or more times per week in the last four weeks and improving when away from work, prevalences among participants were elevated: 10.4 times higher for wheeze, 5.2 for chest tightness, 7.9 for attacks of shortness of breath, 5.3 for coughing attacks, 2.5 for headaches, 4.8 for dry or itchy skin, and 5.9 for throat symptoms (Table 10).

Spirometry Tests

Results of the spirometry tests showed that 21 of the 24 participants (88%) had normal lung function at the time of testing. No participants had airways obstruction, but three participants had restriction. These three employees had high body mass indices (a ratio of height to weight squared) of over 30. A high body mass index is a risk factor for extra-pulmonary restriction.

Methacholine Challenge Tests

Of the 23 employees who performed MCT, one employee had bronchial hyperresponsiveness with a PC_{20} of 1.2 mg/mL. Two additional employees had borderline bronchial hyperresponsiveness with PC_{20}s of 5.3 mg/mL and 12.6 mg/mL.

Exhaled Nitric Oxide

Four of the 24 employees (17%) had exhaled NO values from 16 ppb to 19 ppb, suggestive of airways inflammation.

Serial Spirometry

We deemed serial spirometry interpretation unreliable in the absence of an abnormal MCT because although a number of employees did exhibit a higher than normal diurnal variability on three or more days (9/18 or 50%), in most cases this variability did not correlate with MCT, exhaled NO, or work-related symptom abnormalities. One employee with borderline bronchial hyperresponsiveness and an exhaled NO value suggestive of inflammation had higher than normal peak flow and FEV_1 diurnal variability as well as evidence of improvement in lung function while at work, with peak flow and FEV_1 values that tended to be higher on work days and peak flow values that showed an upward trend over the workweek. One employee with borderline bronchial hyperresponsiveness and an exhaled NO value suggestive of inflammation had higher than normal peak flow and FEV_1 diurnal variability as well as serial spirometry results which suggested a work-related pattern, with peak flow values that tended to be higher during a week away from work.

Summary of Medical Test Results

Seven of the participants had some indication of abnormal lung function or exhaled nitric oxide levels suggestive of airways inflammation. All seven of these participants reported having current upper or lower respiratory, or constitutional symptoms that they thought may be related to the building. One of the three participants with pulmonary restriction reported recent work-related constitutional symptoms consistent with hypersensitivity pneumonitis including fatigue, flu-like achiness, and fever and chills, and all three reported some of these constitutional symptoms within the past 12 months.

Three of these seven employees had bronchial hyperresponsiveness or borderline bronchial hyperresponsiveness and exhaled nitric oxide levels suggestive of inflammation, consistent with poorly controlled asthma. Furthermore, one of these three employees had some indication of a work-related pattern of lung function on serial spirometry, consistent with work-related asthma. Another of the three with both abnormal tests had evidence of improvement at work based on higher peak expiratory flow and FEV_1 levels at work,

consistent with asthma exacerbated or caused by an exposure away from work.

Four of the seven participants with some indication of abnormal lung function or exhaled nitric oxide levels suggestive of airways inflammation did not report physician-diagnosed asthma or hypersensitivity pneumonitis, and none reported current respiratory medications.

DISCUSSION

The major environmental findings in the Webster Springs District Office were water incursion, visible mold, and musty odors in the basement. Damp buildings are associated with risk of nose and throat symptoms, cough, wheeze, asthma symptoms in sensitized persons, and hypersensitivity pneumonitis.[23] In addition, some evidence suggests that exposures in damp indoor environments are associated with shortness of breath and development of asthma.[23] Thus, the recurrent dampness in this building is a plausible cause of some of the health symptoms and medical conditions reported by the employees.

Environmental Surveys

We compared the April 2004 temperature measurements made during the site visits to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommendations for indoor temperatures during the winter.[24] The highest maximum temperature was greater than the ASHRAE recommended maximum of 75°F; all other measurements were within the recommended range (68-75°F). Minimum relative humidity readings below 30% were measured in all three indoor locations during the April 2004 survey and no maximum readings were above 60% in any location. The Environmental Protection Agency recommends low indoor humidity, ideally between 30 and 50% when possible.[25]

At the time of the survey, ASHRAE recommended "…an indoor to outdoor differential concentration not greater than about 700 ppm of CO_2".[26] Outdoor measurements taken in April 2004 averaged approximately 475 ppm. During the first week of the site visit, CO_2 levels were elevated during the work day (maximum of 1562 ppm). This finding implies that the outdoor air supply was insufficient for the number of occupants in these areas (see Evaluation Criteria section). ASHRAE recommends an outdoor air supply rate of 15 cubic feet per minute per person for office spaces where the occupancy is known,[22] though even this ventilation rate may be inadequate to prevent complaints such as mucous membrane irritation and eye symptoms.[27] The finding of elevated CO_2 concentrations was communicated to the building maintenance crew who made changes to the ventilation system (i.e., opened outside air louvers and fixed improperly installed filters) the week after the site visit. Concentrations of CO_2 were then shown to be lower during the weeks after the site visit (Figure 2).

Volatile organic compounds (VOCs) are present in the indoor environment as airborne vapors. Sources may include building materials, microbial growth, cleaning agents, perfumes, and solvents. Most of the detected VOCs are commonly found in office buildings.[22] The estimated concentrations indicate that all detected VOCs were below occupational exposure limits.

Our sampling indicated that fine particulate concentrations were generally higher indoors than outdoors in this building. The back stairs area and the file room values were very similar, which was expected given their close proximity. The values in Social Services were generally lower than the other two indoor locations sampled. The particulate sampling results indicate that the levels were higher indoors than outdoors, although the outdoor data was limited. Values from the three indoor sample locations were similar to each other from day to day. In April and May 2004, particulate concentrations did not follow the expected pattern of increasing during the work day in relation to occupant activity and decreasing during the night and over the weekends. Instead, particle count concentrations increased during the night and decreased during the day. Particulate count

concentrations rose sharply on two weekends: April 24-25 and May 8-9. The highest spike in particles occurred at all three indoor locations on May 11 near the end of the work day. Particle count concentrations then decreased overnight, but were still high relative to the other days. It is unknown what caused these spikes, and most of the particles were smaller than one micrometer aerodynamic diameter.

Although there are no established exposure limits for airborne fungi levels, the comparison of fungal levels and composition of fungal flora found indoors on the second floor and outdoors can be a useful tool for evaluating potential indoor fungal contamination.[28] If no internal building reservoir of fungi exists, the major source of indoor fungi is the outdoors, and the composition of indoor and outdoor fungal flora should be similar.[29] In a building with fungal contamination, the fungal flora composition is often different from outdoors because internal sources can modify indoor fungal composition.[30] During the September 2003 site visit, air samples demonstrated that the outdoor composition was similar to the indoor composition and that indoor airborne fungal spore levels were lower than those outdoors. Our subsequent finding in April 2004 that visible mold was present in the basement indicates that an indoor fungal source existed at that time. It had been raining before and during the April 2004 visit, but not during the September 2003 visit. Employee reports of previous musty odors and visible mold growth suggest that indoor fungal sources were at least intermittently present.

Epidemiologic Surveys

Our questionnaire surveys documented high rates of work-related respiratory symptoms. Excesses of symptoms and asthma diagnoses were evident compared to both national and state rates. The high participation rates preclude participation bias as an explanation. In fact, the burden of disease may have been underestimated because one employee was on medical leave and others may have left employment prior to our survey because of illness.

One explanation for the excess prevalence of physician-diagnosed asthma might be an overzealous health practitioner, as many employees were seen by the same physicians who referred patients largely to one pulmonologist. The NIOSH testing indicated that only three of the six employees reporting current asthma had objective medical test results supporting a respiratory diagnosis, which in one case was unlikely to be asthma (restrictive spirometry). However, adequately-treated asthmatics should have normal methacholine, exhaled nitric oxide, and spirometry tests, and the absence of objective confirmation does not preclude a correct diagnosis of asthma.

More worrisome was our identification of four persons with pulmonary function abnormalities who did not report a physician diagnosis of asthma or hypersensitivity pneumonitis. Two of the four had restriction, one had an exhaled nitric oxide level suggestive of inflammation, and one had both methacholine and exhaled nitric oxide tests consistent with poorly-controlled asthma. None were being treated with respiratory medication.

Wet buildings are associated with asthma exacerbation, if not onset, and with hypersensitivity pneumonitis. In the first survey, one participant reported both asthma and hypersensitivity pneumonitis, but the latter diagnosis was not reported in the second survey by the same participant. One participant who reported asthma had a spirometry abnormality (restriction) which is better explained by hypersensitivity pneumonitis. Two other employees also had restrictive abnormalities on spirometry. The constellation of respiratory and constitutional symptoms of fever, profound fatigue, and achiness is consistent with hypersensitivity pneumonitis. Asthma alone does not produce constitutional symptoms. Many physicians do not consider the diagnosis of hypersensitivity pneumonitis and may miss early disease if the chest x-ray is normal or misdiagnose it as pneumonia if the chest image is abnormal. In this employee population, we do not know if hypersensitivity pneumonitis was misdiagnosed as asthma, present in symptomatic people without diagnoses, or truly absent.

We had hoped to demonstrate whether or not work-related patterns of spirometry existed among symptomatic employees. We concluded that a work-related pattern existed in one such person. During our evaluation of the data, we were unsure how to interpret serial spirometry patterns in those without evidence of bronchial hyperreactivity. However, three weeks may be an insufficient period of time to demonstrate a work-related pattern, even when it exists. In summary, the serial spirometry added little to our assessment of asthma among employees. Nevertheless, the asthma excess and clustering in time suggests work-relatedness in a building with a known risk factor – recurrent water incursion and dampness.

CONCLUSIONS

Our survey identified respiratory symptoms and conditions in employees that may be related to the workplace. Among participants, the prevalences of physician-diagnosed and current asthma were high when compared to national and state prevalences, as were prevalences of building-related symptoms. The building was found to have standing water, mold, and musty odors in the basement. Musty odors were also present in other parts of the building. The documented health effects and the environmental findings of water damage, standing water, and mold dictate continued remediation efforts to improve the conditions in the building as a means to protect the health of occupants and to prevent additional health effects.

RECOMMENDATIONS

- Management should fix water incursion in the basement, maintain sump pumps, and ensure that storm water run-off is channeled away from the building.
- Management should clean or remove previously wetted items stored in the basement.
- Management should identify and remediate areas of previous or current mold growth in the basement.
- Management should leave restroom fans on during the day and ensure that the restrooms remain under negative pressure in relation to the office space.
- Management should hire a qualified firm to balance the HVAC system to ensure the correct proportion of supply and return air and to ensure that adequate outside air is brought into the system.
- Employees should seek physician advice for management of lower and upper respiratory symptoms, asthma, and allergies, and for consideration of further evaluation of potential work-relatedness.

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Table 1. Environmental sampling by location for the September 2003 and April 2004 surveys.

Location	Both Surveys	September 2003 Survey		April 2004 Survey		
	Analyte/Measurement	Analyte	Analyte	Analyte	Analyte	Analyte
File room	CO_2[a], Temp[b], RH[c]	Fungal spores	VOCs[d] (tube)	Particle counts	VOCs (canister)	
Social Services area	CO_2, Temp, RH	Fungal spores	VOCs tube)	Particle counts		
Cubicle near back stairs	CO_2, Temp, RH	Fungal spores	VOCs (tube)	Particle counts		
Outdoors	CO_2, Temp, RH	Fungal spores	VOCs (tube)	Particle counts	VOCs (canister)	
Receptionist office		Fungal spores	VOCs (tube)			
Cubicle near computer server room		Fungal spores				
Conference room		Fungal spores				
Women's restroom					VOCs (canister)	
Interrogation office					VOCs (canister)	
Basement					VOCs (canister)	Bio-Tape™ surface sample

[a]Carbon dioxide concentration
[b]Temperature
[c]Relative Humidity
[d]Volatile organic compounds

Table 2. Summary statistics of carbon dioxide concentration, temperature, and relative humidity from the September 2003 and April 2004 surveys and total particulate counts from the April 2004 survey.

Location/Statistic	Carbon dioxide (ppm)		Temperature (°F)		Relative Humidity (%)		Total Particulate* (particles/m^3)
	Sept	April	Sept	April	Sept	April	April
Cubicle near back stairs							
- Average	555	592	73.3	75.3	37.3	34.9	36,862,678
- Minimum	483	397	71.5	70.3	34.4	25.2	1,935,000
- Maximum	950	1562	74.5	78.5	43.3	43.8	168,230,000
File room							
- Average	564	576	72.0	75.4	40.5	35.7	41,321,027
- Minimum	474	377	70.2	70.9	38.2	26.9	2,030,000
- Maximum	1038	1347	72.9	78.3	43.5	43.7	195,732,000
Social Services area							
- Average	643	556	72.7	75.8	42.2	35.0	31,618,537
- Minimum	476	392	70.9	69.2	40.6	17.1	1,820,000
- Maximum	1095	1412	73.6	79.9	45.2	42.4	189,275,008
Outdoors							
- Average	472	475	98.9	80.4	24.2	18.2	28,706,241
- Minimum	363	448	79.0	70.5	17.1	14.6	20,955,000
- Maximum	569	510	109.8	90.4	43.3	22.8	37,245,000

* Total particulate includes all particles greater than 0.3 μm, which is the lower detection limit of the instrument.

Table 3. Fungal spore counts from air samples taken at 15 L/min for 5 minutes in five areas of the building and outside (September 11, 2003).

	Social Services		File room		Conference room		Cubicle near computer room		Cubicle near back stairwell		Receptionist		Outside	
	Raw count	Spores /m^3	Raw count	Spores /m^3	Raw count	Spores /m^3	Raw count	Spores /m^3	Raw count	Spores /m^3	Raw count	Spores /m^3	Raw count	Spores /m^3
Alternaria													1	13
Ascospores					4	53	20	267	8	107	8	107	52	693
Basidiospores					4	53							712	9,490
Cladosporium	4	53	8	107	4	53	4	53	4	53	4	53	144	1,920
Curvularia													3	40
Other brown spores	1	13					1	13	1	13	1	13		
Penicillium/*Aspergillus* types†	4	53	4	53	4	53	4	53	8	107	4	53	24	320
Pithomyces	1	13											1	13
Polythrincium													1	13
Smuts, *Periconia*, Myxomycetes	1	13											7	93
Torula													1	13
Background debris ††	2+		2+		2+		2+		2+		2+		2+	
Sample volume (liters)	75		75		75		75		75		75		75	
Total spores/m^3		145		160		212		386		280		226		12,608

† The spores of *Aspergillus* and *Penicillium* (and others such as *Acremonium*, *Paecilomyces*) are small and round with very few distinguishing characteristics. They cannot be differentiated by non-viable sampling methods. Also, some species with very small spores are easily missed, and may be undercounted.

†† Background debris is an indication of the amount of non-biological particulate matter present on the slide (dust in the air) and is graded from 1+ to 4+, with 4+ indicating the largest amounts.

Table 4. Volatile organic compounds collected with thermal desorption tubes (September 11, 2003).

Volatile Organic Compound	Social Services	File Room	Back Stairs	Reception	Outdoors
Formaldehyde**	X			X	X
Propane	X	X	X	X	X
Dichlorodifluoromethane					X
Methanol*/acetaldehyde**/,isobutane	X	X	X	X	X
Butane	X	X	X	X	X
Ethanol	X	X	X	X	X
Acetone*	X	X	X	X	X
Isopropanol*	X	X	X	X	
Pentane*	X		X		X
C5H8 isomer (isoprene)	X	X	X	X	X
Methyl acetate*	X	X	X	X	X
1-Propanol		X	X	X	
C6 aliphatic hydrocarbons (methyl pentanes)	X	X	X	X	X
Acetic acid*	X	X	X	X	X
Hexane*	X	X		X	X
Ethyl acetate	X	X	X	X	
Methyl propionate*	X	X	X	X	X
1,1,1-Trichloroethane		X	X	X	
Methylcyclopentane					X
C7 aliphatic hydrocarbons	X		X	X	X
Benzene*/butanol*	X	X	X	X	X
1-Methoxy-2-propanol*	X	X	X	X	
Ethylene glycol	X				
Pentanal*	X	X	X		
Isooctane	X	X	X	X	X
Heptane*	X	X	X	X	X
Methyl butyrate*/butyl formate*	X	X	X	X	X
Propylene glycol	X	X	X		
Methylcyclohexane*/methyl iso-butyl ketone	X	X	X	X	X
C8 aliphatic hydrocarbons	X	X	X	X	X
Dimethyl formamide (DMF)		X			
Amyl alcohol	X				
Toluene*	X	X	X	X	X
Butyric acid*	X	X	X	X	X
Hexanal*	X	X	X	X	X
Dimethyl dioxane*	X	X	X	X	X
Butyl acetate*	X	X	X	X	X
Furfural/perchloroethylene	X	X	X	X	

Table 4 (continued). Volatile organic compounds detected with thermal desorption tubes.

Volatile Organic Compound	Social Services	File Room	Back Stairs	Reception	Outdoors
Hexamethylcyclotrisiloxane*	X	X	X	X	
1-Propoxy-2-propanol	X				
Propylene glycol methyl ether acetate *		X		X	X
Ethyl benzene/xylene isomers	X	X	X	X	X
Heptanal*	X	X	X	X	X
Styrene	X	X	X	X	
Butyl cellosolve*	X	X		X	X
Nonane		X	X	X	X
2-Butoxy-1-propanol	X	X	X		
Butyl propionate*					
Benzaldehyde	X	X	X	X	X
?-Pinene	X	X	X	X	
M.W.120, C9H12 alkyl benzenes (trimethyl benzenes, etc.)	X	X	X		X
Fatty acid (caproic)	X	X	X	X	
Phenol	X	X	X	X	
6-Methyl-5-hepten-2-one		X	X	X	
Butyl butyrate*	X	X	X	X	X
Octanal*	X	X	X	X	X
Octamethylcyclotetrasiloxane*	X	X	X	X	
Decane	X	X	X	X	
2-Ethyl-1-hexanol*	X	X	X	X	
C10-C16 aliphatic hydrocarbons plus some C9-C10 alkyl benzenes	X	X	X	X	X
Limonene*	X	X	X	X	
Acetophenone	X	X	X	X	
Nonanal*	X	X	X	X	X
Undecane	X	X	X	X	
Benzyl acetate	X	X	X	X	
Camphor*					
Decamethylcyclopentasiloxane*	X	X	X	X	X
2(2-Butoxyethoxy)ethanol	X	X	X	X	
Menthol	X	X	X	X	
Naphthalene	X	X	X	X	X
Decanal*	X	X	X	X	
Dodecane	X	X	X	X	X
Caprolactam/benzothiazole	X	X	X	X	
Tripropylene glycol?			X		
Isobornyl acetate?	X			X	

Table 4 continued. Volatile organic compounds detected with thermal desorption tubes.

Volatile Organic Compound	Social Services	File Room	Back Stairs	Reception	Outdoors
Tridecane	X	X	X	X	
Dodecamethylcyclohexasiloxane*	X	X	X	X	
C12H24O3, methyl propanoic acid esters	X	X	X	X	X
Tetradecane	X	X	X	X	
Phthalic anhydride*					
Dimethylphthalate*					X
Fatty acid*	X	X	X	X	X
Pentadecane	X	X	X	X	
Diethylphthalate*	X	X	X	X	X
Aliphatic acid ester*	X	X	X	X	X
Hexadecane	X	X	X		
Aliphatic, oxy compounds (alcohols?)	X	X	X		

* Also present in system blank and/or on some field or media blanks.
** May be present as an impurity and/or thermal decomposition products of methanol/ethanol.

Table 5A. Compound concentrations in parts per billion by volume (ppb) (quantitated based on calibration curve) from canister sampling (April 2004).

Compound	Sampling Location					
	File Room	Interrogation office	Basement	Women's restroom	Basement	Outdoors
Propylene	16	N.D.[A]	1	1	1	1
Freon-12	2	5	1	2	1	<1[B]
Chloromethane	<1	N.D.	N.D.	N.D.	N.D.	N.D.
Ethanol	392[C]	131[C]	6	4190[C]	5	22
Acetone	31	23	11	49	21	8
Freon-11	<1	3	2	2	2	N.D.
Isopropyl alcohol	80[C]	268[C]	10	288[C]	9	3
Methylene chloride	<1	<1	1	2	<1	2
Freon-113	<1	<1	<1	<1	<1	<1
Methyl ethyl ketone	<1	<1	N.D.	<1	N.D.	3
Hexane	N.D.	N.D.	N.D.	N.D.	<1	N.D.
Chloroform	N.D.	<1	<1	<1	N.D.	N.D.
1,1,1-Trichloroethane	<1	N.D.	N.D.	N.D.	N.D.	N.D.
Benzene	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	<1	<1	<1	<1	<1	<1
Cyclohexane	N.D.	N.D.	N.D.	N.D.	N.D.	2
Heptane	<1	N.D.	<1	<1	<1	N.D.
Methyl isobutyl ketone	<1	<1	N.D.	N.D.	N.D.	N.D.
Toluene	2	1	2	1	1	<1
Methyl butyl ketone	N.D.	N.D.	N.D.	N.D.	N.D.	<1
Tetrachloroethylene	N.D.	N.D.	N.D.	N.D.	N.D.	<1
Ethyl benzene	<1	<1	<1	<1	<1	<1
m,p Xylene	<1	<1	<1	<1	2	<1
Styrene	<1	<1	N.D.	<1	N.D.	N.D.
o-Xylene	<1	<1	<1	<1	<1	<1
4-Ethyltoluene	N.D.	N.D.	N.D.	<1	<1	N.D.
1,3,5-trimethyl-Benzene	<1	<1	N.D.	<1	<1	N.D.
1,2,4-trimethyl Benzene	<1	N.D	<1	<1	3	<1

[A]Non-detectable (i.e., no peak at compound retention time).
[B]Lower than the estimated limit of quantification of 1 ppb.
[C]Estimated concentration due to being greater than maximum calibration concentration.

Table 5B. Compound concentrations in ppb (quantitated on toluene response) from canister sampling (April 2004).

Compound	Sampling Location					
	File Room	Interrogation Office	Basement	Women's restroom	Basement	Outdoors
Acetaldehyde	N.D.[A]	5	N.D.	N.D.	N.D.	N.D.
1,2,3-trimethyl-Benzene,	N.D.	N.D.	N.D.	N.D.	2	N.D.
2-[(trimethylsilyl)oxy]-Benzoic acid	11	N.D.	4	4	6	2
Butane	N.D.	1	N.D.	2	2	N.D.
octamethyl-Cyclotetrasiloxane	4	N.D.	N.D.	5	19	10
hexamethyl-Cyclotrisiloxane	3	1	N.D.	1	16	7
Decane	N.D.	N.D.	N.D.	N.D.	2	N.D.
D-Limonene	N.D.	3	2	5	1	10
Isobutane	N.D.	N.D.	2	N.D.	N.D.	N.D.
Naphthalene	N.D.	N.D.	N.D.	N.D.	3	N.D.
trimethyl-Silanol	2	N.D.	N.D.	N.D.	N.D.	N.D.
Tridecane	N.D.	N.D.	N.D.	N.D.	3	N.D.
Undecane	N.D.	N.D.	N.D.	N.D.	3	N.D.
2,6-dimethyl-Undecane	N.D.	N.D.	N.D.	N.D.	1	N.D.

[A]N.D. = Non-detectable (i.e., no peak at compound retention time).

Table 6. Selected demographics among the 24 participants (April 2004).

Age (Mean Years ± SD)	42.9 ± 9.8
Race (% White)	24/24 (100%)
Gender (% Female)	19/24 (79%)
Building tenure (Mean Years ± SD)	5.1 ± 3.4
Current smoker (%)	4/24 (17%)
Former smoker (%)	4/24 (17%)
Never smoker (%)	16/24 (67%)

Table 7. Physician-diagnosed conditions among participants (April 2004).

Physician-diagnosed conditions	Overall (%)
Asthma, ever	8/24 (33)
Asthma, current	6/24 (25)
Asthma, post-occupancy	7/24 (29)
Asthma, post-occupancy and current	5/24 (21)
Hypersensitivity pneumonitis	0/24 (0)

Table 8. Prevalence of symptoms and work-related symptoms which occurred during the last 12 months in 24 building occupants (April 2004).

Symptom	Anytime in the past 12 months		Anytime in the past 12 months **AND** "got better" when away from work	
	n	%	n	%
Wheeze or whistling in chest	16	66.7	9	37.5
Chest tightness	16	66.7	9	37.5
Attacks of shortness of breath	15	62.5	6	25.0
Coughing attacks	15	62.5	9	37.5
Awakened by an attack of breathing difficulty	11	45.8	4	16.7
Shortness of breath when hurrying on level ground or walking up a slight hill	15	62.5	3	12.5
Cough with phlegm	16	66.7	5	20.8
Fever or chills	9	37.5	3	12.5
Flu-like achiness or achy joints	21	87.5	7	29.2
Excessive fatigue	16	66.7	10	41.7
Drowsiness or memory or concentration difficulty	18	75.0	8	33.3
Headaches	17	70.8	10	41.7
Stuffy, itchy, or runny nose	22	91.7	9	37.5
Sneezing	18	75.0	10	41.7
Rash or itchy skin	14	58.3	9	37.5
Watery or itchy eyes	16	66.7	8	33.3
Hoarseness or dry, sore or burning throat	20	83.3	13	54.2
Sinusitis or sinus problems	19	79.2	10	41.7
Pneumonia	0	0.0	N/A	N/A
Cold	14	58.3	N/A	N/A

Table 9. Comparison of symptom prevalences in 24 building occupants and the adult U.S. population (NHANES III) (April 2004).

Symptom	Prevalence ratio [A]	95% CI
Shortness of breath while hurrying on level or walking up a slight hill [B]	3.1	1.9-5.1
Wheeze or whistling in chest in the last 12 months	4.1	2.5-6.7
Sinusitis or sinus problems in the last 12 months	1.8	1.2-2.9
Stuffy, itchy or runny nose in the last 12 months	1.5	1.0-2.3
Watery, itchy eyes in the last 12 months	1.5	0.9-2.4

[A] Prevalence ratios calculated as the number of people with the outcome in the building occupants divided by the number of people expected to have the outcome based on U.S. population data, adjusting for age, gender, race, and smoking status.

[B] Our question differed from the NHANES question in that ours pertained to the last 12 months.

Table 10. Prevalence of symptoms in 24 building occupants which occurred at least once per week in the last four weeks, work-related symptoms, and comparison with U.S. office workers (April 2004).

Symptom	At least 1-3 times per week in the last 4 weeks (%)		At least 1-3 times per week in the last 4 weeks **AND** "got better" when away from work (%)		Prevalence ratio for symptoms that "got better" away from work[A]	95% CI
	n	%	n	%		
Wheeze or whistling in chest	11	45.8	6	25.0	10.4	4.8-22.7
Chest tightness	5	20.8	3	12.5	5.2	1.8-15.3
Shortness of breath[B]	8	33.3	4	16.7	7.9	3.1-20.4
Cough[C]	10	41.7	7	29.2	5.3	2.6-11.0
Awakened by an attack of breathing difficulty	3	12.5	2	8.3	N/A[†]	N/A
Shortness of breath when hurrying on level ground or walking up a slight hill	11	45.8	2	8.3	N/A	N/A
Cough with phlegm	10	41.7	4	16.7	N/A	N/A
Fever or chills	6	25.0	3	12.5	N/A	N/A
Flu-like achiness or achy joints	11	45.8	6	25.0	N/A	N/A
Unusual tiredness or fatigue	15	62.5	9	37.5	N/A	N/A
Drowsiness or memory or concentration difficulty	17	70.8	8	33.3	N/A	N/A
Headaches	15	62.5	10	41.7	2.5	1.4-4.6
Stuffy, itchy, or runny nose	16	66.7	8	33.3	N/A	N/A
Sneezing	18	75.0	10	41.7	N/A	N/A
Dry or itchy skin	8	33.3	6	25.0	4.8	2.2-10.5
Watery or itchy eyes	14	58.3	8	33.3	N/A	N/A
Throat[D] Symptoms	13	54.2	10	41.7	5.9	3.2-10.8
Sinusitis or sinus problems	16	66.7	9	37.5	N/A	N/A

[A] 1-3 times per week in the last four weeks and better away from work, as compared with U.S. office workers (BASE)

[B] Our question differed from the BASE question in that we used the phrase "attacks of shortness of breath".

[C] Our question differed from the BASE question in that we used the phrase "coughing attacks".

[D] Our question differed from the BASE question in that ours asked about hoarseness, or dry, sore, or burning throat.

[†] No comparison can be made to BASE data

Figure 1. Hourly mean data for carbon dioxide concentrations indoors (Sept. 2003).

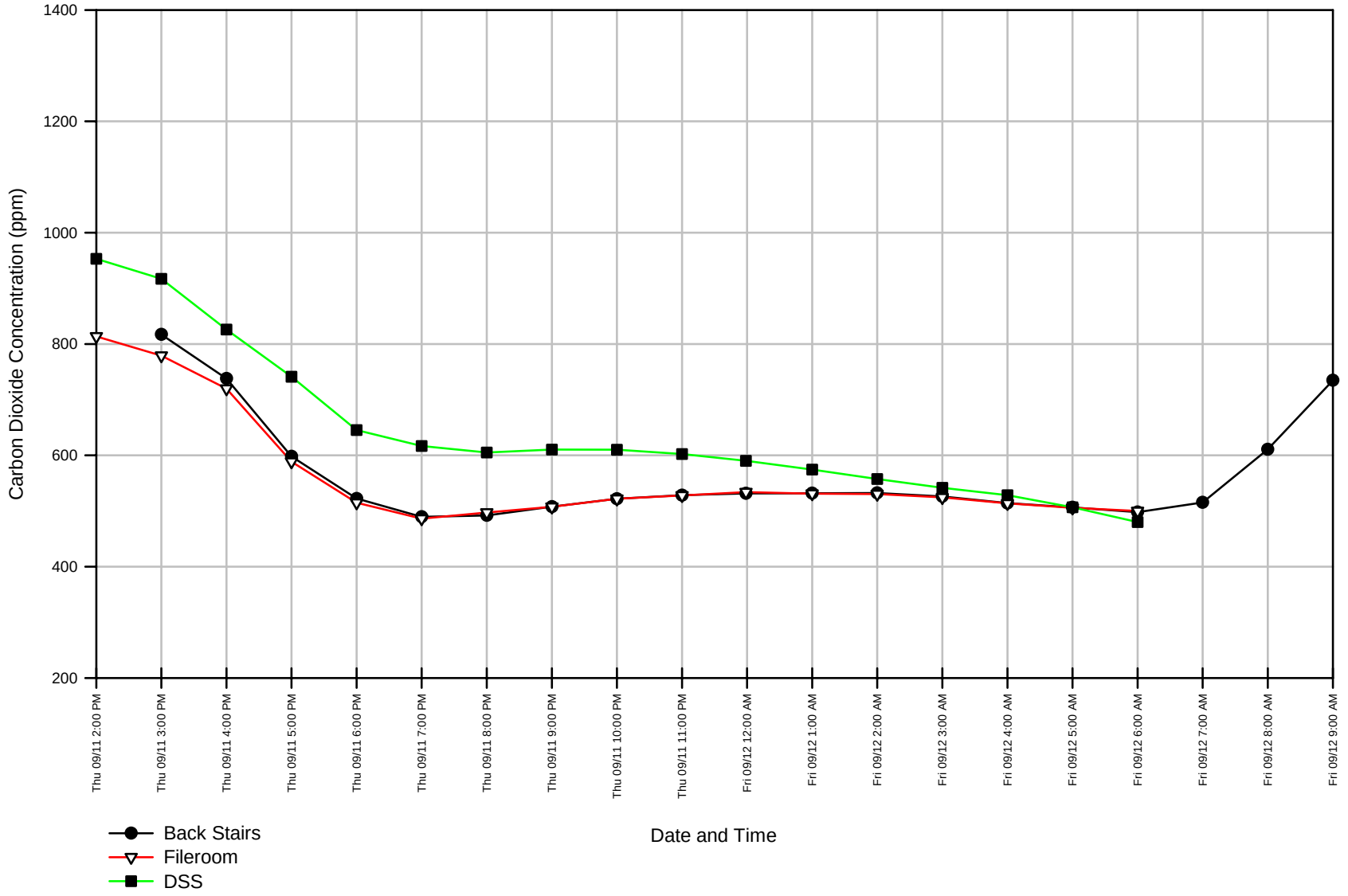


Figure 2. Carbon dioxide concentrations from April 13 – May 12, 2004. Changes were made to the ventilation system between April 16th and 18th, as recommended.

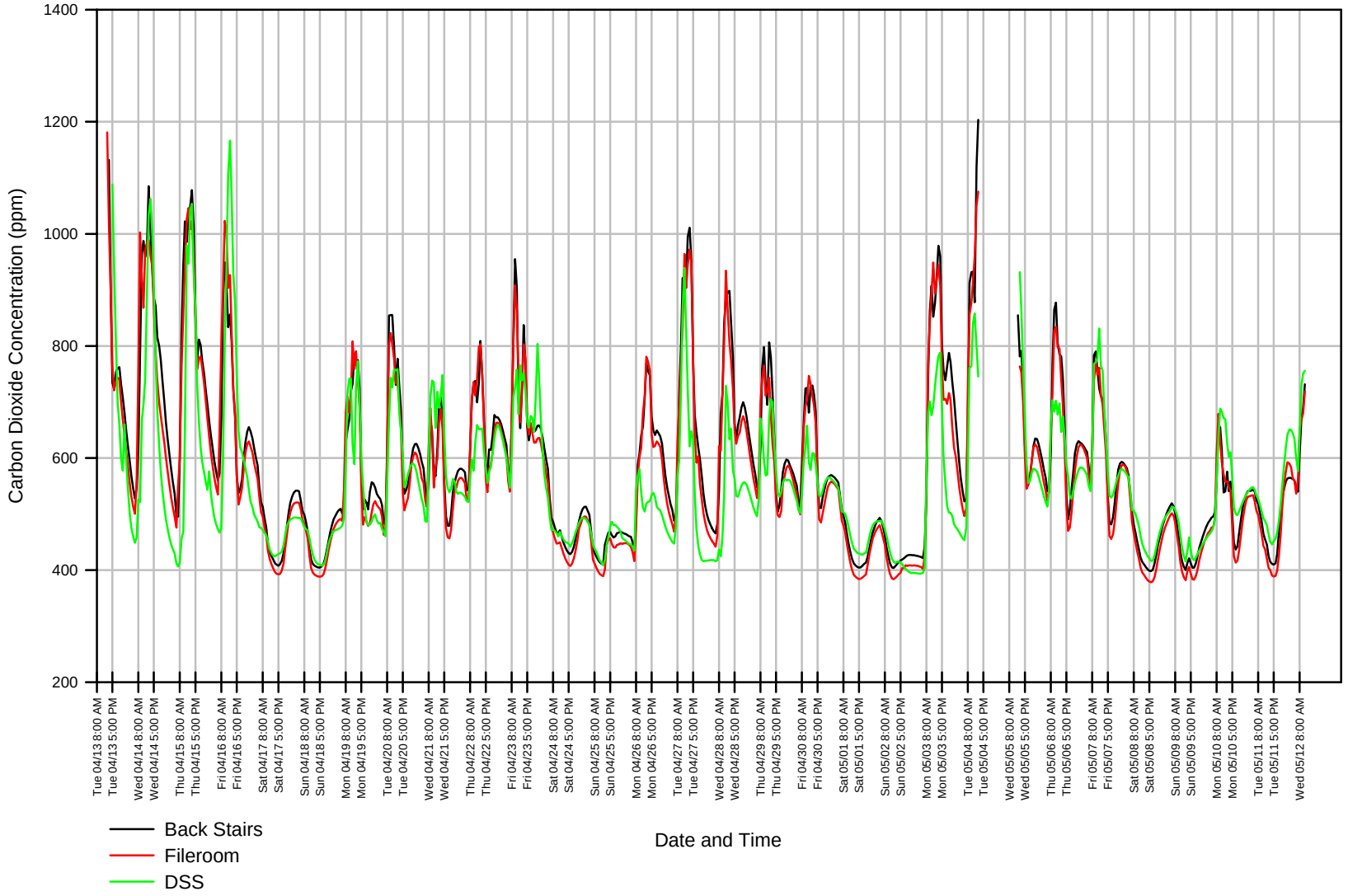


Figure 3. Hourly mean data of submicron particles from April 13 – May 12, 2004.

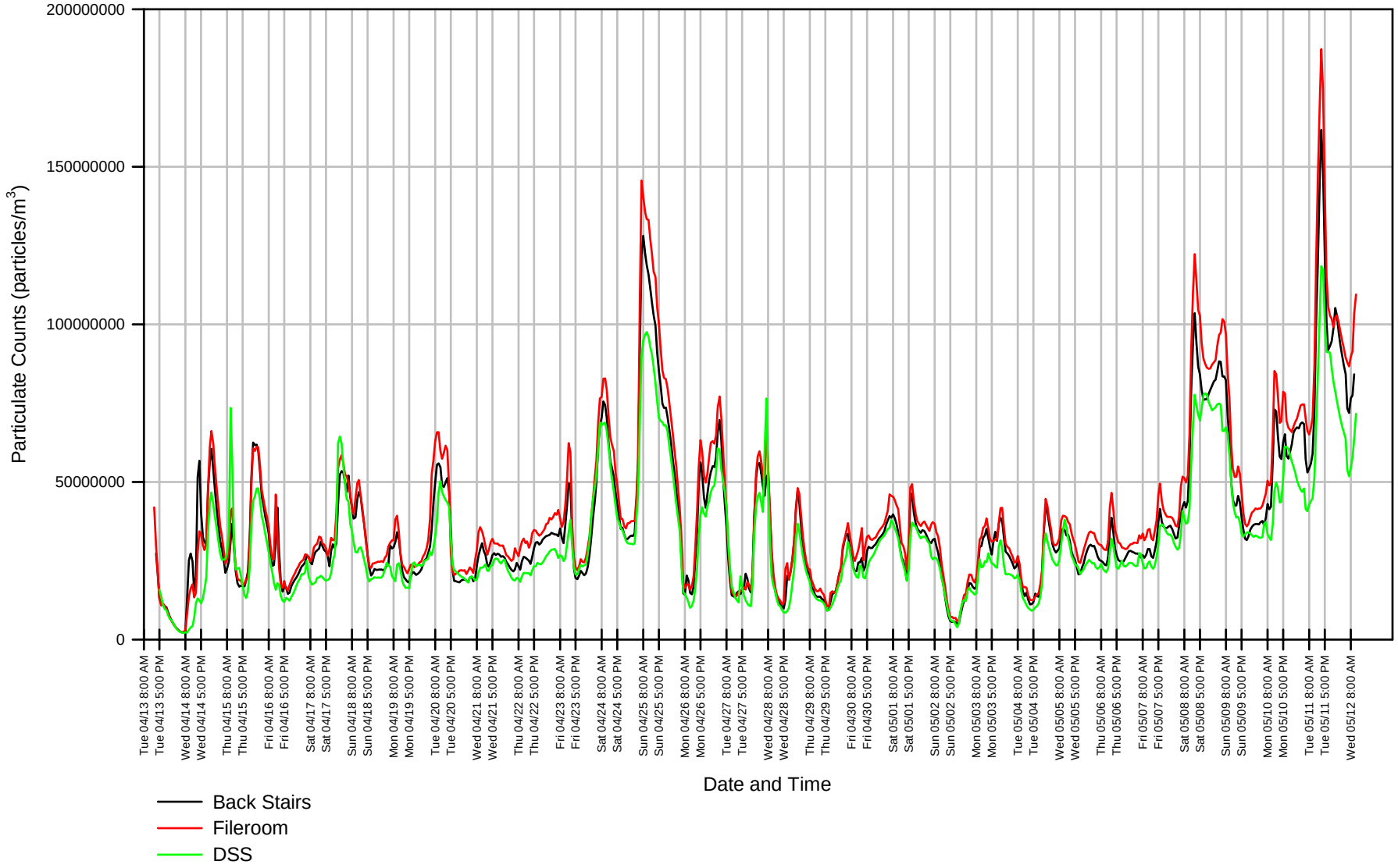
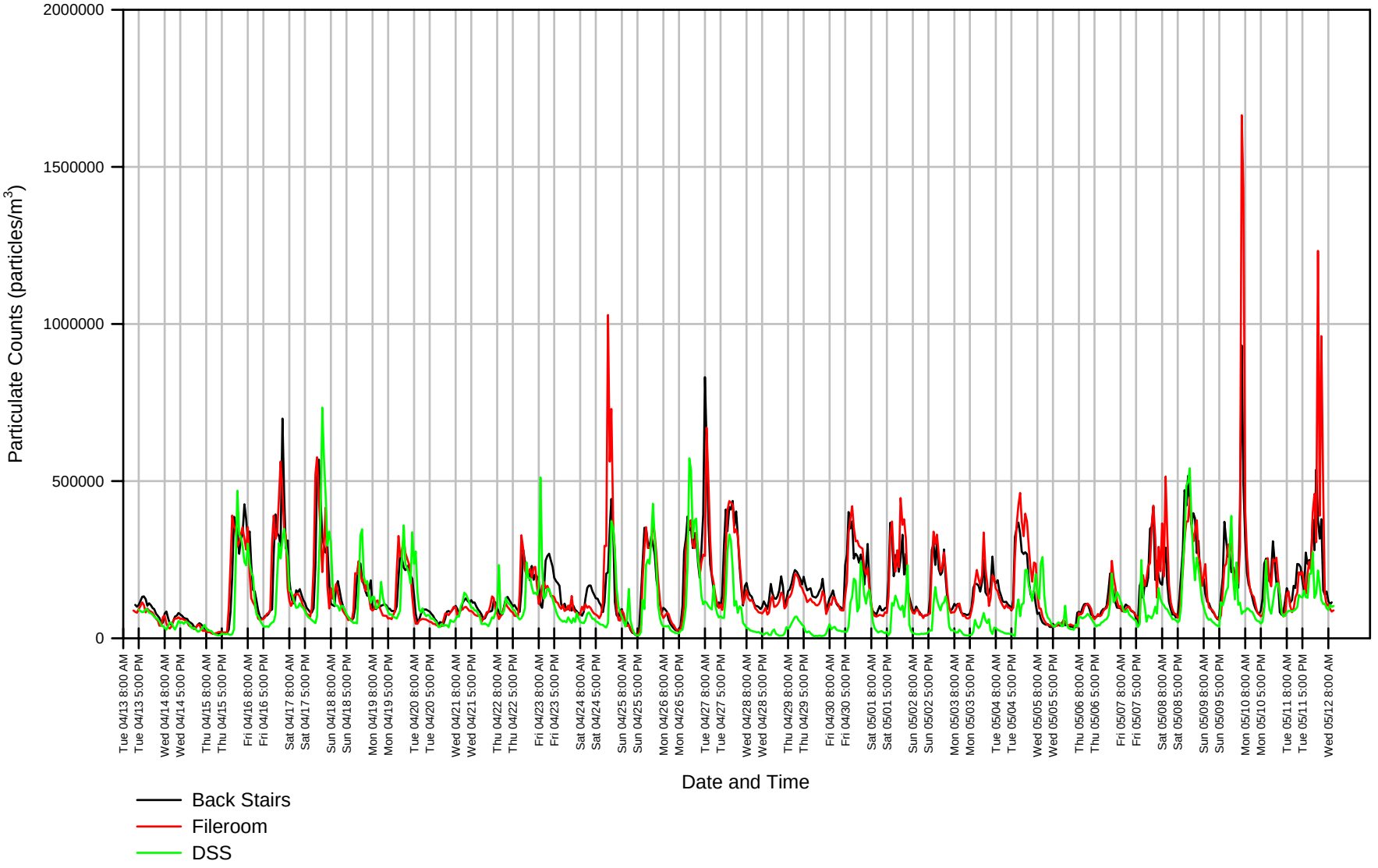


Figure 4. Hourly mean data of particles sized between one and ten micrometers from April 13 – May 12, 2004.



APPENDIX A

Acronym and Abbreviation List

ACGIH = American Conference of Governmental Industrial Hygienists
ASHRAE = American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BASE = Building Assessment Survey and Evaluation study
BHR = bronchial hyperresponsiveness
BRFSS = Behavioral Risk Factor Surveillance System
CI = confidence interval
CO_2 = carbon dioxide
DSS = Department of Social Services
ºF = degrees Fahrenheit
FE_{NO} = fractional concentration of exhaled nitric oxide
FEV_1 = forced expiratory volume in one second
FVC = forced vital capacity
GC/MS = gas chromatography/mass spectrometry
HVAC = heating, ventilation, and air-conditioning system
L/min = liters per minute
LLN = lower limit of normal
m^3 = cubic meters
MCT = methacholine challenge test
mg/mL = milligrams per milliliter
µm = micrometers
n = number (of employees)
N/A = not applicable
N.D. = not detectable
NHANES = National Health and Nutrition Examination Study
NIOSH = National Institute for Occupational Safety and Health
NO = nitric oxide
O/E = observed/expected
OSHA = Occupational Safety and Health Administration
PC_{20} = provocative concentration of methacholine causing a 20% fall in FEV1
PEF = peak expiratory flow
PEL = permissible exposure limit
ppb = parts per billion
ppbv = parts per billion by volume
ppm = parts per million
REL = recommended exposure limit
RH = relative humidity
SD = standard deviation
STEL = short-term exposure limit
TLV = threshold limit value
TWA = time-weighted average
VOC = volatile organic compound
WVDHHR = West Virginia Department of Health and Human Resources
WVDNR = West Virginia Department of Natural Resources

APPENDIX B

Questionnaire

Form Approved
OMB No. 0920-0260
Expires June 3, 2004

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

West Virginia Department of Health and Human Services
Webster District Office
HETA-2003-0300

The National Institute for Occupational Safety and Health (NIOSH) is a part of the United States Public Health Service and an institute within the Centers for Disease Control and Prevention (CDC) that is concerned with workplace health and safety. We have received a Health Hazard Evaluation request to evaluate health concerns that may be related to your workplace environment. The purpose of this evaluation is to determine if exposures in the building may be associated with health effects in workers.

This is a questionnaire about your health history and work history. Although participation is entirely voluntary, NIOSH feels it is important for you to complete the questionnaire in order for the study to be successful. The overall study results (without names or other personal identifying information) will be provided to the requesters and the West Virginia Department of Health and Human Services; the West Virginia Department of Health and Human Services is required to post a copy of the final report in a place accessible to employees for a period of 30 days. In addition, if you so request, NIOSH will send you a copy of the final report.

All medical and other personal information that you provide NIOSH is considered confidential in accordance with the Privacy Act of 1974 (Public Law 93-579). The information you provide NIOSH will be used for statistical and research purposes and will be summarized so that no individual is identified. All information is stored at NIOSH until destroyed. Management will not see your response.

"BY COMPLETING THIS QUESTIONNAIRE AND SIGNING OUR CONSENT FORM, YOU INDICATE YOUR CONSENT TO PARTICIPATE IN THIS STUDY."

Thank you for your participation.

Subject ID _____
Interviewer ID _____

1. Date: __ __/__ __/2004

2. Name: _____ _____ _____
First MI Last

3. Address: _____
Street

_____ _____ _____
City State Zip

4. Home Phone: _____ Work Phone:_____

5. Date of Birth: __ __ / __ __ / __ __ __ __
Month Day Year

6. Gender: ____ Male
____ Female

7. Ethnicity (Please choose one):
____ Yes, Hispanic or Latino
____ No, Not Hispanic or Latino

8. Race (Please choose all that apply):
____ American Indian or Alaska Native
____ Asian
____ Black or African American
____ Native Hawaiian or Other Pacific Islander
____ White

1.1 In the past 12 months have you had wheezing or whistling in your chest? Yes ___ No ___

IF YES:

1.2 Have you had wheezing or whistling in your chest one or more times per week in the last 4 weeks? Yes ___ No ___

1.3 When you were away from the building was the wheezing or whistling: Same ___ Worse ___ Better ___

1.4 In what month and year did you first have wheezing or whistling in your chest? __ __ / __ __ __ __

2.1 In the past 12 months have you had chest tightness? Yes ___ No ___

IF YES:

2.2 Have you had chest tightness one or more times per week in the last 4 weeks? Yes ___ No ___

2.3 When you were away from the building was the chest tightness: Same ___ Worse ___ Better ___

2.4 In what month and year did you first have chest tightness? __ __ / __ __ __ __

3.1 In the past 12 months have you had attacks of shortness of breath? Yes ___ No ___

IF YES:

3.2 Have you had attacks of shortness of breath one or more times per week in the last 4 weeks? Yes ___ No ___

3.3 When you were away from the building were the attacks of shortness of breath: Same __ Worse__ Better__

3.4 In what month and year did you first have attacks of shortness of breath? __ __ / __ __ __ __

4.1 In the past 12 months have you had coughing attacks? Yes ___ No ___

IF YES:

4.2 Have you had coughing attacks one or more times per week in the last 4 weeks? Yes ___ No ___

4.3 When you were away from the building were the coughing attacks: Same ___ Worse ___ Better ___

4.4 In what month and year did you first have coughing attacks? __ __ / __ __ __ __

5.1 In the past 12 months have you been awakened by an attack of breathing difficulty? Yes ___ No ___

IF YES:

5.2 Have you been awakened by an attack of breathing difficulty one or more times per week in the last 4 weeks? Yes ___ No ___

5.3 When you were away from the building was the awakening by attacks of breathing difficulty: Same___ Worse___ Better___

5.4 In what month and year were you first awakened by an attack of breathing difficulty? __ __ / __ __ __ __

6.1 In the past 12 months have you had shortness of breath when hurrying on level ground or walking up a slight hill? Yes ___ No ___

IF YES:

6.2 Have you had shortness of breath when hurrying on level ground or walking up a slight hill one or more times per week in the past 4 weeks? Yes ___ No ___

6.3 When you were away from the building was the shortness of breath: Same ___ Worse ___ Better ___

6.4 In what month and year did you first have this shortness of breath? __ __ / __ __ __ __

7.1 In the past 12 months have you had cough with phlegm? Yes ___ No ___

IF YES:

7.2 Have you had cough with phlegm one or more times per week in the last 4 weeks? Yes ___ No ___

7.3 When you were away from the building was the cough with phlegm: Same ___ Worse ___ Better ___

7.4 In what month and year did you first have cough with phlegm? __ __ / __ __ __ __

8.1 In the past 12 months have you had episodes of fever and chills? Yes ___ No ___

IF YES:

8.2 Have you had episodes of fever and chills one or more times per week in the last 4 weeks? Yes ___ No ___

8.3 When you were away from the building were these episodes of fever and chills? Same___ Worse___ Better___

8.4 In what month and year did you first have episodes of fever and chills? __ __ / __ __ __ __

9.1 In the past 12 months have you had episodes of flu-like achiness or achy joints? Yes ___ No ___

IF YES:

9.2 Have you had episodes of flu-like achiness or achy joints one or more times per week in the last 4 weeks? Yes ___ No ___

9.3 When you were away from the building was the flu-like achiness or achy joints: Same___ Worse___ Better__

9.4 In what month and year did you first have episodes of flu-like achiness or achy joints? __ __ / __ __ __ __

10.1 In the past 12 months have you had excessive fatigue? Yes ___ No ___

IF YES:

10.2 Have you had excessive fatigue one or more times per week in the last 4 weeks? Yes ___ No ___

10.3 When you were away from the building was the excessive fatigue: Same ___ Worse ___ Better ___

10.4 In what month and year did you first have excessive fatigue? __ __ / __ __ __ __

11.1 In the past 12 months have you had drowsiness or memory or concentration difficulty? Yes ___ No ___

IF YES:

11.2 Have you had drowsiness or memory or concentration difficulty one or more times per week in the last 4 weeks? Yes ___ No ___

11.3 When you were away from the building was the drowsiness or memory or concentration difficulty: Same ___ Worse ___ Better ___

11.4 In what month and year did you first have drowsiness or memory or concentration difficulty? __ __ / __ __ __ __

12.1 In the past 12 months have you had headaches? Yes ___ No ___

IF YES:

12.2 Have you had headaches one or more times per week in the last 4 weeks? Yes ___ No ___

12.3 When you were away from the building were the headaches: Same ___ Worse ___ Better ___

13.1 In the past 12 months have you had a stuffy, itchy or runny nose? Yes ___ No ___

IF YES:

13.2 Have you had a stuffy, itchy or runny nose one or more times per week in the last 4 weeks? Yes ___ No ___

13.3 When you were away from the building was the stuffy, itchy or runny nose: Same ___ Worse ___ Better ___

14.1 In the past 12 months have you had sneezing? Yes ___ No ___

IF YES:

14.2 Have you had sneezing one or more times per week in the last 4 weeks? Yes ___ No ___

14.3 When you were away from the building was the sneezing: Same ___ Worse ___ Better ___

15.1 In the past 12 months have you had a rash or itchy skin? Yes ___ No ___

IF YES:

15.2 Have you had a rash or itchy skin one or more times per week in the last 4 weeks?	Yes ___ No ___
15.3 When you were away from the building was the rash or itchy skin:	Same ___ Worse ___ Better ___
15.4 In what month and year did you first have a rash or itchy skin?	__ __ / __ __ __ __

16.1 In the past 12 months have you had watery or itchy eyes? Yes ___ No ___

IF YES:

16.2 Have you had watery or itchy eyes one or more times per week in the last 4 weeks?	Yes ___ No ___
16.3 When you are away from the building were the watery or itchy eyes:	Same ___ Worse ___ Better ___
16.4 In what month and year did you first have water or itchy eyes?	__ __ / __ __ __ __

17.1 In the past 12 months have you had hoarseness or a dry, sore or burning throat? Yes ___ No ___

IF YES:

17.2 Have you had hoarseness or a dry, sore or burning throat one or more times per week in the last 4 weeks?	Yes ___ No ___
17.3 When you are away from the building was the hoarseness or dry, sore or burning throat:	Same ___ Worse ___ Better ___
17.4 In what month and year did you first have hoarseness or a dry, sore or burning throat?	__ __ / __ __ __ __

18.1 In the past 12 months have you had sinusitis or sinus problems? Yes ___ No ___

IF YES:

18.2 Have you had sinusitis or sinus problems in the last 4 weeks?	Yes ___ No ___
18.3 How many episodes of sinusitis or sinus problems have you had in the last 12 months?	_____
18.4 When you were away from the building were the sinusitis or sinus problems:	Same___ Worse___ Better___
18.5 In what month and year did you first have sinusitis or sinus problems?	__ __ / __ __ __ __

19.1 In the past 12 months have you had pneumonia? Yes ___ No ___

IF YES:

19.2 Have you had pneumonia in the last 4 weeks?	Yes ___ No ___
19.3 How many times have you had pneumonia in the last 12 months?	_____

20.1 In the past 12 months have you had a cold? Yes ___ No ___

IF YES:

20.2 Have you had a cold in the last 4 weeks?	Yes ___ No ___
20.4 How many times have you had a cold in the last 12 months?	_____

21.1 Has a physician ever told you that you have asthma? Yes ___ No ___

IF YES:

21.2 Date of asthma diagnosis: __ __ / __ __ __ __

21.3 Do you still have asthma? Yes ___ No ___

22.1 Has a physician ever told you that you have hypersensitivity pneumonitis? Yes ___ No ___

IF YES:

22.2 Date of hypersensitivity pneumonitis diagnosis: __ __ / __ __ __ __

23.1 Have you ever smoked cigarettes regularly? Yes ___ No ___

IF YES:

23.2 Do you still smoke cigarettes? Yes ___ No ___

24.1 What was the date you started working at the Webster Springs Office? __ __ / __ __ __ __

24.2 Have you had symptoms that you think may be related to the building? Yes ___ No ___

IF YES:

24.3 When did the symptoms begin?

_____

_____

24.4 Do you still have the symptoms? Yes ___ No ___

24.5 What are the symptoms?

_____

_____

_____

APPENDIX C

Questions Programmed into the EasyOne Spirometer

1. What type of session do you want to do?
   a. First thing on getting up in the morning
   b. During the day
   c. Bedtime

The type of session will determine when the following questions are asked:

Question for waking blow:

2. What time did you get up today?
   Please enter the hour you got up today, then press enter followed by 1 for AM or 2 for PM.

Question for blow on arrival to work or mid-morning:

3. Is today a workday?
   a. Yes
   b. No

   3a. **If Yes**, Please enter the hour you started work, then press enter followed by 1 for AM or 2 for PM.

Question for blow before dinner:

4. Is today a workday?
   a. Yes
   b. No

   4a. Please enter the hour you quit work, then press enter followed by 1 for AM or 2 for PM.

Questions asked during each session:

Choose one response for each question.

1. What is your location for this session?
   a. Work
   b. Home
   c. Other

2. In the last 2 hours did you use your fast-acting, rescue inhaler?
   a. Yes
   b. No

3. In the last 2 hours did you smoke or were you exposed to tobacco smoke?
   a. No/None
   b. Breathed 2nd hand-smoke
   c. Smoked cigarette
   d. Smoked cigar or pipe

4. In the last 2 hours did you have eye, nose, or throat irritation?
   a. Yes
   b. No

5. In the last 2 hours did you have a cough attack, wheeze, chest tightness or shortness of breath?
   a. Yes
   b. No

6. In the last 2 hours have you been exposed to dust, gases, or chemical fumes/vapors?
   a. Yes
   b. No

APPENDIX D

Interim Letters

October 1, 2003
HETA 2003-0300
Interim Letter 1

Mr. Bill Adamy
WV Department of Health and Human Resources
110 North Main Street, Suite 201
Webster Springs, West Virginia 26288

Dear Mr. Adamy:

On June 13, 2003, NIOSH received a Health Hazard Evaluation request from Mr. John Boles, Director of the Office of Facility Management for the office space in Webster Springs leased by the West Virginia Department of Health and Human Resources. As a part of the Health Hazard Evaluation investigation of this office space, NIOSH conducted a walkthrough on September 11 and 12, 2003. During the visit, NIOSH investigators spoke with employees, administered questionnaires, and conducted an industrial hygiene evaluation that included air sampling for mold and volatile organic compounds; pressure mapping; and direct-reading measurements for temperature, humidity, carbon dioxide, and ultrafine particulate counts. From our observations during the walkthrough, the following recommendations are made:

1. Operate exhaust fans in each restroom all day to ensure a negative pressure in the space. During the evaluation, investigators noted that the restrooms were under positive pressure in relation to the hallway when the exhaust fans were not operating, allowing air to move from the restrooms into the hallway. When exhaust fans were turned on for 20 minutes, the pressure in the restrooms was neutral (not positive or negative) in relation to the hallway. This may be the source of some of the "chemical" odors noted by employees. Currently, building occupants can turn the exhaust fans on and off. Consider rewiring the exhaust fans so they run constantly and are not operable by the building occupants. Also, consider reducing the flow of air through the supply vent or increasing the exhaust to the restroom area to keep the area under negative pressure. Insure that the minimum ventilation required by the city building codes for public restrooms is met.
2. Verify that the ventilation units on the roof are properly draining water from the drip-pan. We noted that the three Carrier® air handlers on the roof drained water onto the rooftop from the trap only when the fan was off. The movement of air from the fan across the drip-pan may be causing enough pressure to keep the water in the pan instead of draining out. The main concern with this scenario is that water may be spraying into the ductwork and fan casing lining because of the full drip-pan and/or drip-pan overflow. A ventilation expert should evaluate the height and the depth of the trap and the pitch of the drip-pan to insure proper

drainage. In addition, they should check if water has sprayed into the ductwork and if so, check if there has been any microbial contamination because of the overspray.

Industrial hygiene samples are being analyzed at this time and will be detailed in a later report. Thank you again for your cooperation with the walkthrough last week. If you have any questions regarding these recommendations, please feel free to contact us at 1-800-232-2114.

Sincerely,

Jeana M. Harrison, M.S.
Industrial Hygienist
Respiratory Disease Hazard Evaluations and
Technical Assistance Program
Field Studies Branch
Division of Respiratory Disease Studies

cc: John A. Boles, Jr.
Jennifer Meeks, Esq.

February 10, 2004
HETA # 2003-0300
Interim Letter II

William Adamy
WV Department of Health and Human Resources
110 North Main Street, Suite 201
Webster Springs, West Virginia 26288

Dear Mr. Adamy:

This letter is written in follow-up to our conversation on January 7, 2004. We are concerned that a large number of employees in the West Virginia Department of Health and Human Resources - Webster Springs office have reported illnesses. Thirty-six percent of questionnaire participants report a physician diagnosis of asthma. More than half of the workers report the use of respiratory medications. In addition, 20 of 22 questionnaire participants report that their symptoms get better when they are away from work. These numbers are very high when compared to state or national references.

We are discussing a potential follow-up visit to further evaluate and characterize the health problems among your employees. During the return visit, we will ask employees to participate in serial respiratory testing to determine if there are work-related patterns of breathing dysfunction. This visit will also include a more in-depth walk-through of the building by our industrial hygienists to look for potential causes of the health problems reported. We will be in contact with you regarding this visit.

We are always available if you have any questions or concerns about the building, the health of your employees, or any other matters related to this investigation. Our toll-free number is 1-800-232-2114.

Sincerely,

Lisa G. Benaise, M.D., M.P.H.
Epidemic Intelligence Service Officer

Jeana M. Harrison, M.S.
Industrial Hygienist
Respiratory Disease Hazard Evaluations
and Technical Assistance Program
Field Studies Branch
Division of Respiratory Disease Studies

cc:
David Hildreth
Patricia Myers, Employee Representative
Diane Forbes, Employee Representative
Sally Conley, Employee Representative
Jason Najmulski,, Regional Director
OSHA, Region 3
Richard Hartle (HETAB)

APPENDIX E

Remediation and Preventive Measures Completed by Building Owners in April 2004

Actions	Intended Effects
Adjusted louvers of the ventilation unit serving the middle portion of the second floor	Increase fresh air intake and lower carbon dioxide levels inside
Fixed the ventilation unit serving the middle portion of the second floor	Increase fresh air intake and lower carbon dioxide levels inside
Corrected improper installation of ventilation filters	Ensure proper filtration of outside air
Installed a new fan in the women's restroom*	Prevent the chemical odors previously reported in office areas
Cleaned the basement	Lower current mold and odors that may migrate to the second floor
Fixed sump pumps in the basement	Prevent standing water and mold growth
Verified that there was no moisture in the elevator room	N/A

* In May 2004, a NIOSH industrial hygienist and city employee determined that the restroom fans exhaust to the outside.

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 a 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 increases 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 Recommended Exposure Limits (RELs),[1] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[2] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[3] 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 short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific 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 STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Microbiologicals

Microorganisms are ubiquitous in the indoor environment. All microorganisms produce antigen–molecules (often proteins or polysaccharides) that stimulate the immune system of exposed persons. A single exposure to an antigen may result in sensitization. If the sensitized person is re-exposed to the same antigen, a hypersensitive or allergic response may occur to a level of antigen that would elicit little or no reaction from non-sensitized persons. Allergic reactions to inhaled antigens may be limited to the upper respiratory tract (e.g., allergic rhinitis), or they may affect the distal airways (e.g., allergic asthma) or the distal portions of the lung (e.g., hypersensitivity pneumonitis).

No standards or guidelines have been set by NIOSH, OSHA, or ACGIH® for culturable or countable bioaerosols.[4] The ACGIH policy[5] is that a general TLV® for culturable or countable bioaerosol is currently not scientifically supportable because:

1. Culturable microorganisms and countable biological particles do not comprise a single entity.
2. Human responses to bioaerosols range from innocuous effects to serious, even fatal, diseases depending on the specific material involved and employees' susceptibility to it.
3. It is not possible to collect and evaluate all bioaerosol components using a single sampling method (different methods of collection and analyses may result in different estimates of concentration).
4. At present, information relating culturable or countable bioaerosol concentrations to health effects is generally insufficient to describe exposure-response relationships.

"Specific TLVs® for individual culturable or countable bioaerosols have not been established to prevent hypersensitivity, irritant, or toxic responses. At present, information relating culturable or countable bioaerosol exposure to health effects consists largely of case reports and qualitative exposure assessments."[5] Therefore, results of airborne bacteria and fungi air sampling should not be used for compliance testing. Air sampling for microbials provides short-term "snapshot" which may not be representative of the fungal conditions over the whole work day or under different environmental conditions. Because of the limitations in air sampling for fungi and bacteria, air sampling results should not be used to prove a negative case. Microbes in air vary seasonally, diurnally, and with occupant activity level. These data should be used to help characterize the microbial environment rather than to evaluate levels as non-hazardous or hazardous.

Particle Concentration

No standards or guidelines have been set by NIOSH, OSHA, or ACGIH® for particle concentrations typical of indoor air. Therefore, results of indoor particle concentrations should not be used for compliance testing. These data should be used to help characterize the indoor environment rather than to evaluate levels as non-hazardous or hazardous.

Carbon Dioxide

Carbon dioxide (CO_2) is a normal constituent of exhaled breath and a product of combustion. High concentrations of CO_2, a colorless, odorless gas that displaces oxygen, can cause death. Lower concentrations can cause symptoms such as headache, sweating, rapid breathing, and increased heart rate.

CO_2 measurements can be used to assess adequacy of air supply to indoor environments. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard recommends an indoor to outdoor differential concentration not greater than 700 ppm of CO_2.[6] The average outdoor (ambient) CO_2 concentration is assumed to be 300 ppm. Thus, when indoor CO_2 concentrations exceed 1000 ppm, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. It is important to note that a CO_2 concentration below 1000 ppm is not an effective indicator of ventilation adequacy if the ventilated area is not occupied at its usual level.

The OSHA PEL (8-hour time-weighted average (TWA)), ACGIH® TLV® (8-hour TWA), and NIOSH REL (10-hour TWA) is 5,000 ppm for carbon dioxide. These exposure limits apply to industrial, not indoor, work environments.

Relative Humidity, Temperature, and Outdoor-Air Exchange Rate

At the time of the survey, ASHRAE recommended that relative humidity in indoor environments be maintained between 30% and 60% relative humidity[6] and that the indoor temperature range provide for

occupant comfort (73-79°F in the summer and 68-75°F in the winter).[7] ASHRAE also recommends an outdoor-air exchange rate for office buildings of 5 cubic feet per minute per person.[6]

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