NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2004-0344-2954

West Virginia University
Robert C. Byrd Health Sciences Center
Morgantown, West Virginia

February 2005

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DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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 (OSHA) 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 employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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 Jennifer Mosser and Terri Pearce of RDHETAP, Division of Respiratory Disease Studies (DRDS). Field assistance was provided by Michael Beaty. Desktop publishing was performed by Terry Rooney. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Indoor Air Quality

NIOSH received a health hazard evaluation request to conduct an indoor air quality evaluation at the West Virginia University, Robert C. Byrd Health Sciences Center, Student Health Services area in Morgantown, West Virginia. Employees reported asthma and respiratory symptoms.

What NIOSH Did

- Conducted visual inspection of the facility on two separate occasions
- Monitored the workplace for indoor air quality parameters (temperature, relative humidity, carbon dioxide, and carbon monoxide)
- Provided feedback to management about conditions and activities within the space that could potentially have adverse impacts on indoor air quality

What NIOSH Found

- Evidence of previous water incursion in several offices and one clinical exam room
- Elevated carbon dioxide concentrations in the employee office area of Student Health Services
- Photographic chemical leaks through the ceiling of one office from an x-ray developer located on the floor above Student Health Services
- Unevenness of the floors in hallways and two occupied offices caused by water incursion beneath the building

What WVU Health Sciences Center Managers Can Do

- Ensure that adequate fresh air is supplied to the occupied spaces and that the HVAC is operating according to the design specifications
- Respond to water incursion events as they occur and provide for thorough methods of discovery for identifying and correcting water damage or mold
- Relocate the x-ray developer to another area or re-plumb the drain to avoid future leaks
- Re-purpose the offices that have experienced subsurface lifting of the floor

What Workers Can Do

- Report indoor air quality concerns and health symptoms to management
- Promptly report leaks or other factors that might impact air quality
- Comply with policies that are designed to protect air quality

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 #2004-0344-2954

Health Hazard Evaluation Report 2004-0344-2954
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Robert C. Byrd Health Sciences Center

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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a request from the Health and Safety Manager at West Virginia University, Robert C. Byrd Health Sciences Center in Morgantown, West Virginia, to conduct an indoor air quality investigation in the Student Health Services employee office area. Employees had expressed concerns about the air quality including the possibility that exposure to photographic chemicals leaking into the office space from the area above might have caused health effects experienced by employees. Primary health concerns were asthma and other respiratory health problems.

The NIOSH response consisted of numerous phone interviews with the requester to gather information, two site visits, and review of material safety data sheets and other information. During the first site visit on September 22, 2004, the industrial hygienist visually inspected the premises and interviewed the Health and Safety Manager. Evidence of previous water incursion in several offices and in one of the clinical exam rooms was observed. Prior to the NIOSH site visit the facilities management staff had investigated the drainage system and identified a downspout that directed storm water to the basement wall. The drainage was corrected and no further water incursion was reported. Other evidence of water incursion was subsurface lifting of the floors which had lead to substantial unevenness of the floors in the hallway and two offices. This was attributed to water incursion below the building that had caused swelling of the natural shale deposits. The second site visit was conducted on November 18, 2004, and included a similar visual inspection of the interior spaces along with the heating and ventilation (HVAC) systems. The second visit also included real-time monitoring of temperature, relative humidity, and concentrations of carbon monoxide and carbon dioxide in the Student Health Service employee office area where respiratory problems have been reported and in the clinic area where there have been no complaints.

Investigation of the two HVAC systems that service the Student Health Service revealed that no outside air was being introduced into the ventilation system. There was indication of continued leaks from the mammography film developer located on the floor above one of the offices. Results of the real-time monitoring found that carbon dioxide concentrations exceeded recommended levels in the employee office area when the building was occupied.

NIOSH conducted two site visits to the West Virginia University, Robert C. Byrd Health Sciences Center, Student Health Services area in Morgantown, West Virginia, to address management concerns about the quality of the indoor air and health effects the employees were experiencing. Areas of previous or ongoing water incursion were found although no mold was observed. Measurements indicated that the office area had elevated levels of carbon dioxide and that changes to the ventilation system were necessary to ensure that adequate fresh air was provided to the occupants.

Keywords: SIC: 8221 (College, Universities & Professional Schools) indoor air quality, IAQ, carbon dioxide, water incursion

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a Health Hazard Evaluation (HHE) request from the Health and Safety Manager at West Virginia University, Robert C. Byrd Health Sciences Center (WVUHSC) in Morgantown, West Virginia. Management was concerned about the air quality in the Student Health Service employee office area and the possibility that exposure to photographic chemicals might have caused health effects experienced by some employees.

BACKGROUND

Employees of WVU Student Health Services are housed in the basement of the Health Sciences building. The space is entirely below ground and has no windows. The area does not appear to have been originally designed for use as office or clinic space but has been modified for that use. The Health and Safety Manager of the WVUHSC, the requester of the HHE, listed the primary health concerns as respiratory problems and asthma-like reactions. Listed exposures included water infiltration during heavy rains, photographic chemicals leaking from the floor above, and poor indoor air quality.

Several offices and one clinical exam room had a history of water incursion during heavy rains. The Health and Safety Manager described the history of water incursion in the clinical examination area. Maintenance personnel had discovered an improperly connected water downspout that had allowed water to be transmitted from the roof to the soil in that corner of the building. Corrective actions to reconnect the downspout to the storm water drain had been completed prior to the site visit. No further water incursion had been reported in that area since the repairs were made. An additional instance of water incursion had been reported in another area of the offices along the north exterior wall. The cause was under investigation.

Another item of concern was a previously occupied office that had experienced leaks of photographic chemicals from the drain of a mammography x-ray developer located in the clinical area directly above that office. The occupant had developed asthma-like symptoms and was moved from the space. The leaks had been attributed to biomass accumulation plugging the drain and causing the waste chemicals to overflow. Prior to the first NIOSH site visit, WVUHSC maintenance began adding antimicrobials to the drainage system and physically cleaning the drain to remove microbial buildup. The office furnishings and carpeting had been cleaned and the damaged ceiling tiles and other materials had been replaced.

METHODS

Walk-through Observations

A site visit was conducted on September 22, 2004, to observe the conditions in the Student Health Service area and to familiarize NIOSH personnel with the building layout. The WVUHSC Health and Safety Manager accompanied a NIOSH industrial hygienist on a walk-through during which the Student Health Services offices and clinical examination areas were inspected. During the walk-through, spot-checks were performed using a TSI Q-trak™ to conduct real-time measurements for indoor air quality parameters (temperature, relative humidity, carbon monoxide, and carbon dioxide).

The office that had experienced leaks from the photographic developer was unoccupied during the site visit. Visual inspection found the office to be clean and to have no visible evidence of additional leaks such as stains on ceiling tiles, furnishings, or carpeting.
Occupants were informally interviewed regarding their perceptions of the indoor air quality and their health symptoms.

A walk-through was also conducted in the mammography center on the floor above Student

Health Services. The location of the mammography film developer was examined including the exhaust ventilation and waste chemical drain system.

Indoor Air Quality Measurements

A return visit was conducted on November 18, 2004, to further investigate the conditions in Student Health Services. Visual inspection for signs of mold and moisture was conducted in the offices and clinical rooms, the heating and air conditioning (HVAC) units, and the area above the drop ceiling directly below the mammography film developer drain.

Measurements of temperature, relative humidity, carbon dioxide, and carbon monoxide levels were made in several areas using a TSI Q-trak™ Plus Indoor Air Quality Monitor. Two Q-traks™ were left in the Student Health Service area for a five-day period to monitor these parameters with changes in occupancy. One instrument was placed in the employee conference room in the area where employees have reported respiratory problems, and the other was placed in the hallway on the clinical side.

RESULTS

Air quality measurement results collected in the conference room and the clinic hallway are provided in Figures 1 and 2, respectively. Temperature at both monitoring locations was in the range of 70 to 75 degrees Fahrenheit over the five day sampling period and relative humidity ranged from 30 to 60 percent. Carbon monoxide concentrations were very low to non-detectable, i.e., 0-1 parts per million (ppm). Carbon dioxide concentrations ranged from 300 to 1800 ppm in the employee conference room and from 400 to 1000 ppm in the hallway on the clinic side. Neither of the HVAC units that service the Student Health Service draws air from the outdoors. The HVAC unit that services the employee office area appeared to be approximately 10 years older than the unit that services the clinic side.

The offices and exam room that experienced water infiltration during heavy rains showed no signs of recent incursions. Floor surfaces affected by swelling of the subsurface continued to be uneven although no additional lifting of the floors was observed.

Visual inspection of the office that had previously experienced leaks from the x-ray developer showed a new stain on the recently-replaced ceiling tiles indicating that new leaks had occurred. Piping above the ceiling was found to show signs of rust and was encrusted with dried material. A chemical odor was noticeable in the area above the drop ceiling. The Health and Safety Manager provided copies of material safety data sheets (MSDSs) for the mammography film development chemicals for NIOSH review. A number of employees reported respiratory symptoms that they attributed to being in the offices. Several noted that air quality was worse on the office side of the Student Health Services area than on the clinic side. Copy machine odors were reported by the occupant of an office down the hall from the copier room. Two employees reported that their symptoms began after being exposed to the photographic chemicals leaking from the floor above. The previous occupant of the office that had experienced the leaks reported a physician diagnosis of asthma that the employee attributed to exposure to the glutaraldehyde component of the photographic chemicals.

Some floor surfaces in Student Health Services are uneven and two offices in particular have floors that have noticeable slope. In one office the floor had lifted an interior wall to the point that it caused the ceiling to buckle in one corner. The Health and Safety Manager stated that the floor lifting was an ongoing phenomenon caused by water-induced swelling of the subsurface shale deposits underlying the building. At the time of the visit, the two offices with the most pronounced unevenness of the floors were occupied. In one office, the workstation and chair location was noticeably higher on one side than the other and did not allow proper ergonomic alignment of the worker with the work surface. In the other office, the work

surface was not as noticeably unlevel but the floor in the center of the room was lower than around the walls. The unevenness of the floor in the hallways could provide a trip and fall hazard for persons unfamiliar with the space.

DISCUSSION AND CONCLUSIONS

Measurement values for indoor air quality parameters that were spot-checked during the first site visit and monitored over time during the second site visit were within the recommended ranges except carbon dioxide concentrations in the area where employees have reported respiratory health complaints. Measured values for temperature and relative humidity at both sampling locations were within the acceptable range specified in the American National Standards Institute/American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 55-1992.[1] No regulatory limit has been set for carbon monoxide concentrations in indoor environments however, the levels measured in Student Health Services were well below the Occupational Safety and Health Administration permissible exposure limit of 50 ppm for 1 hour.[2] This value is also lower than the Environmental Protection Agency National Ambient Air Quality Standard of 9 ppm for 8 hours.[3]

The elevated levels of carbon dioxide on the office side of Student Health Services exceeded the ANSI/ASHRAE recommendation that indoor carbon dioxide levels be no more than 700 ppm greater than the outdoor concentration.[4] In most areas of the country, outdoor concentrations are generally in the range of 300 to 350 ppm. Therefore, the usual interpretation of the ANSI/ASHRAE recommendation is a concentration no greater than 1000 to 1050 ppm. The elevated carbon dioxide levels can be attributed to a lack of adequate fresh air in relation to the number of occupants in the space. The Qtrak™ was placed in the conference room as it was a central location on the office side of Student Health Services. Occupants were interviewed regarding the use of the conference room for meetings. No meetings were reported during the sampling period so increases in carbon dioxide over the course of the workday were interpreted as being representative of the total space. The higher levels on November 18, 2004 were attributed to larger numbers of patients on that day as that was the week before the Thanksgiving Holiday and fewer students were reported to use the clinic after that day. The Qtrak™ data (Figures 1 and 2) demonstrates the increases in carbon dioxide concentration over the course of the workday and during times of greater occupancy. Levels were lower on the Friday and Monday workdays when fewer patients were in the space as well as on the weekend when the space was unoccupied. These findings point to the need for increased fresh air in relation to the number of occupants, both employees and patients.

The finding that carbon dioxide levels exceeded the ANSI/ASHRAE recommendations documents the inadequacy of the ventilation system. The current ventilation system does not provide for any outdoor dilution or make-up air to be delivered to the space. The inadequate amount of fresh air supplied to the employee offices appears to be a factor in the employee health symptoms and complaints. The area has no windows so all dilution air must come through the doorways. During business hours, the main door to the office area is kept closed and the main door to the clinic area is open. The open door on the clinic side appears to allow for increased air exchange and consequently helps to maintain lower carbon dioxide levels in that area. While keeping doors open does allow for some air exchange, it is not sufficient as a long term solution and is especially problematic as the use of the space for clinical services means that occupancy fluctuates based upon the number of patients receiving care. If the space continues to be used for these purposes, the ventilation system should be redesigned to provide sufficient amounts of fresh air based upon occupant density.

The history of water incursion into the space and the subsurface lifting of the floors are evidence that this area of the building may be more prone

to dampness and further water incursion. While no visible mold was observed during either site visit, a recent Institute of Medicine report states that the scientific evidence suggests that persons who live or work in damp buildings have more respiratory health symptoms than persons in non-damp buildings.[5] Therefore, it is important to ensure that the Student Health Services area is repaired and maintained in way that prevents water incursion. The offices that have experienced lifting of the floors to the extent that desk areas are not level should be re-purposed for use other than as occupied offices to prevent discomfort for the person using that work space.

Review of the MSDSs for the chemicals used in the mammography film developer (Kodak Miniloader™ 2000P) found that Part B of the developer solution contained glutaraldehyde bis(sodium bisulphite) at a weight concentration of 20-25 percent and glutaraldehyde bis(potassium bisulfite) by weight concentration of 1-5 percent. The MSDS for the combined components (working solution) obtained from the manufacturer's website lists the components of the working solution and their percentages by weight as: water (85-90), potassium sulphite (5-10), hydroquinone (1-5), diethylene glycol (1-5), glutaraldehyde bis(sodium bisulphite) (1-5), and 4-hydroxymethyl-4-methyl-1-phenyl-3-pyrazoloidinone (<1).[6] The leak of the mammography developer that lead to exposure for the office occupant pre-dated the NIOSH site visit so it was not possible to sample the liquids to which the occupant was exposed. However, the MSDS obtained from the manufacturer states that the mixture may liberate sulfur dioxide which can act as a respiratory tract irritant. The glutaraldehyde component of the working solution is also a consideration as glutaraldehyde has been implicated in both acute and chronic effects in health care workers exposed during equipment sterilization or x-ray development.[7] The manufacturer does not specify respiratory protection for employees using the working solution although the stipulation is made that adequate ventilation be provided. The specific chemicals and concentrations that leaked from the mammography developer drain at the time of the occupant's exposure are unknown. However, the types of chemicals found in the working solution are known to be irritating to the respiratory tract even at low concentrations. Knowing that the ventilation system is inadequate in providing dilution ventilation to the office space increases the likelihood that any irritant effects may have been exacerbated.

RECOMMENDATIONS

- If the current HVAC units can be retrofitted to allow for adequate amounts of outside air to be provided to the Student Health Services area, those changes should be made to the system. If the current units are not capable of allowing for outdoor air supply, they should be replaced with units having that capability.
- Relocate the x-ray developer located on the floor above the employee offices or reconfigure the mammography film developer drain system to ensure that additional leakage does not occur.
- Respond to water leaks immediately and provide for thorough methods of discovery for identifying and correcting water damage or mold.
- Re-purpose the two office areas that have experienced substantial lifting of the floor due to subsurface water incursion.

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FIGURES

Figure 1. Indoor Air Quality Values in the Student Health Service employee conference room.

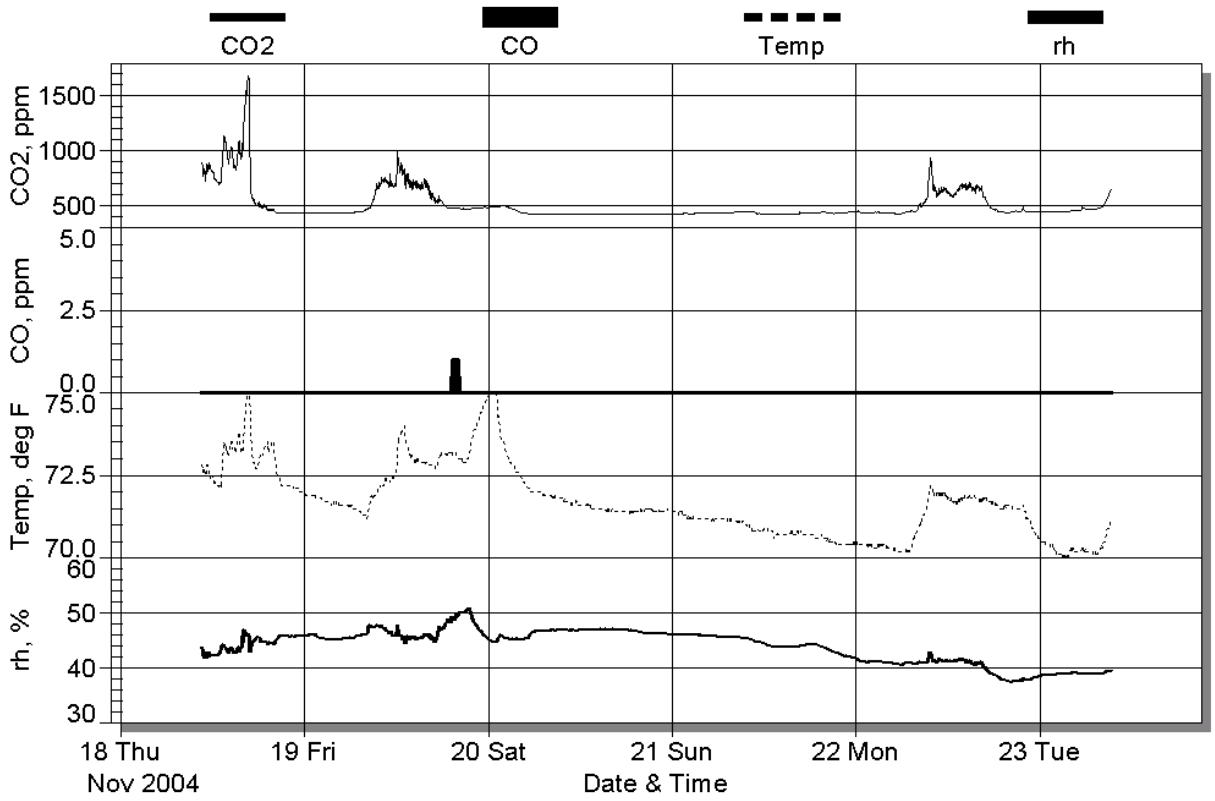
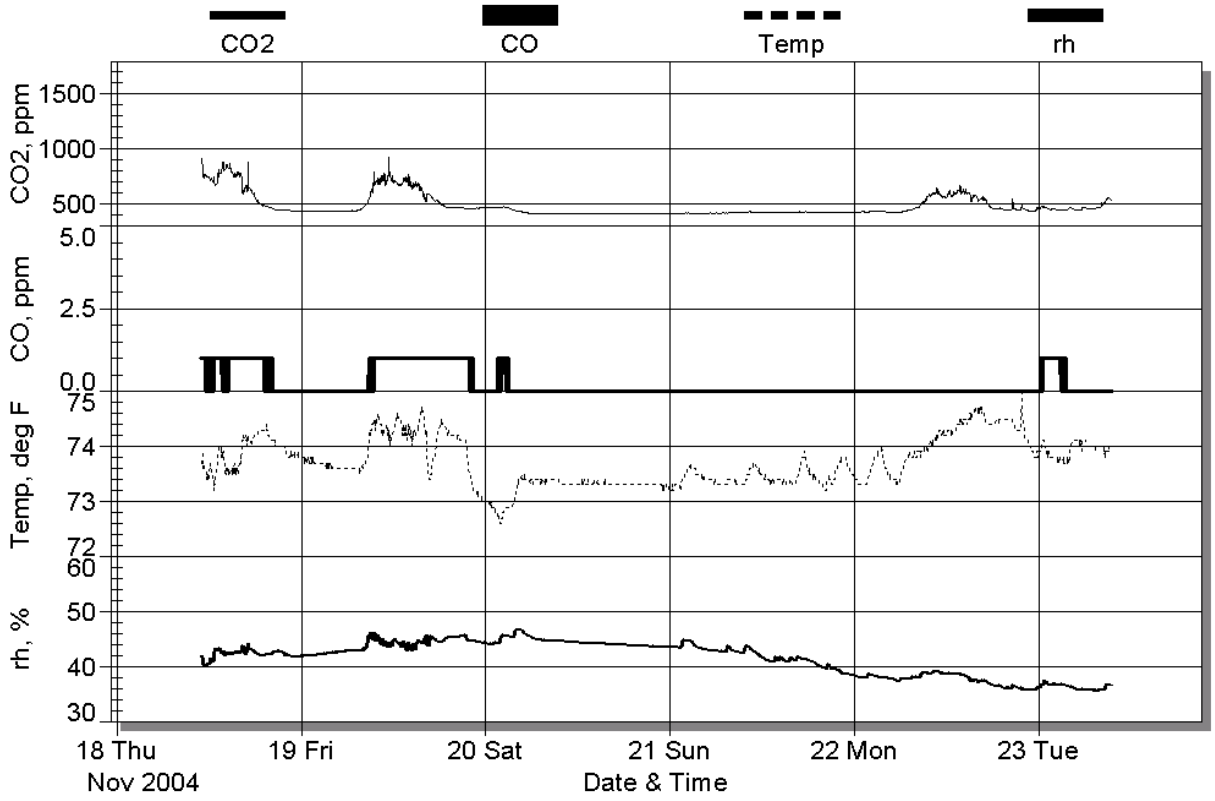


Figure 2. Indoor Air Quality Values in the Student Health Service clinic hallway.



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