# Evaluation of Indoor Environmental Quality and Health Concerns in a Public University

Elena Page, MD, MPH
Kendra Broadwater, MPH
Gregory Burr, CIH


HHE Report No. 2015-0118-3249
March 2016

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

## Contents



The employer is required to post a copy of this report for 30 days at or near the workplace(s) of affected employees. The employer must take steps to ensure that the posted report is not altered, defaced, or covered by other material.

The cover photo is a close-up image of sorbent tubes, which are used by the HHE Program to measure airborne exposures. This photo is an artistic representation that may not be related to this Health Hazard Evaluation. Photo by NIOSH.

# Highlights of this Evaluation

The Health Hazard Evaluation Program received an employer request from a university because some employees had concerns about potential exposure to mold in a campus building. This building was primarily used by the school's speech, language, and hearing department. We visited the facility in July 2015.

## What We Did

- We checked for moisture, water damage, and mold inside the building.
- We looked at the ventilation systems.
- We measured carbon dioxide, temperature, and relative humidity.
- We interviewed employees about their work, medical history, and work-related health concerns.

We evaluated concerns about mold exposure in a university building. We saw no widespread mold or water damage but relative humidity levels were high. This condition can promote the growth of microorganisms and dust mites. Many symptoms reported by employees have been associated with damp buildings and/or inadequate ventilation. These symptoms are also common in the general population. We found no evidence that problems such as hives, fibromyalgia, chronic fatigue syndrome, or hair loss were related to the building. We recommended stopping environmental sampling and improving the building ventilation.

## What We Found

- We found mold growth in a closet in the library on the first floor.
- We found a damp area on a wall in room 209, but we did not see mold growth.
- The heating and cooling systems for the basement, first, and second floors were not designed to bring outdoor air into the building.
- Many window air conditioners did not work properly.
- Floor fans were used in hallways to improve air movement.
- Housekeeping was poor. In some areas we saw cobwebs and dust.
- The temperature range was 68°F to 85°F. The relative humidity range was 35% to 78%. Relative humidity above 65% can promote the growth of microorganisms and dust mites.
- Some employees reported irritated eyes, headache, fatigue, throat irritation, and frequent respiratory infections they related to work. These symptoms could be related to exposure to microbes in the air, but poor ventilation and other factors can also be a cause.
- Two employees with pre-existing asthma said their asthma was worse and they used their inhaler more often while in the building. Asthma can worsen among occupants of damp buildings.

- Some employees reported fibromyalgia, chronic fatigue syndrome, hives, and strep throat. These conditions are not related to working in the building.

## What the Employer Can Do

- Hire a licensed professional mechanical engineer to assess the building's ventilation systems.
- Leave the air-conditioning units on at all times during hot and humid weather.
- Keep hallway doors open as much as possible during normal working hours and on weekends. This will help improve air circulation in the building.
- Stop planned environmental sampling for mold.
- Consider minimizing the use of carpet and upholstered furniture in the building. Porous materials are more difficult to clean than smooth, non-porous surfaces, and can also harbor microbes and dust mites.
- Review the building's preventive upkeep plan with the goal of maintaining a healthy and safe building.
- Include non-management employees on the health and safety committee. This will help improve communication about building issues and efforts.
- Encourage employees to report water leaks or water damage to facilities maintenance.
- Create a system for employees to report building concerns and to receive feedback on how issues were resolved.

## What Employees Can Do

- Report work-related health concerns to school officials.
- See an occupational medicine physician about health problems you think may be related to work.
- Join the indoor environmental quality committee.

# Abbreviations

| | |
|---|---|
| EPA | Environmental Protection Agency |
| IEQ | Indoor environmental quality |
| NIOSH | National Institute for Occupational Safety and Health |
| ppm | Parts per million |
| RH | Relative humidity |

This page left intentionally blank

# Introduction

The Health Hazard Evaluation Program received an employer request from a university because of concerns about exposure to mold in a campus building. School employees reported respiratory illness, hives, sinus infections, hair loss, and gastrointestinal distress that they associated with working in the building. We surveyed the building in July 2015. We met with university administrators and employee representatives to learn more about the concerns. In July 2015, we sent a follow-up letter to university administrators and employee representatives containing our preliminary findings and recommendations.

## Background

The building housed 10 staff and 13 graduate assistants at the time of our evaluation. Constructed in 1954 as a dormitory, it was converted to academic and clinical use in 1968. In 2013, five employees reported a variety of illnesses they believed to be caused by mold exposure. University staff and university-hired consultants inspected the building and found mold growth in some areas. These areas were remediated, and portable dehumidifiers were placed in the building. In 2014, additional employees reported illness they thought was related to mold in the building. At that time, university administrators hired consultants to evaluate conditions and collect air samples for mold.

# Methods

Before our site visit, we reviewed the consultant's March 2015 indoor environmental quality (IEQ) report. The consultant had collected area air samples for fungal spores inside and outside of the building. Mold is a layman's term that refers to fungus. The consultant concluded that because indoor fungal spore levels were similar to outdoor fungal levels, there was no indoor fungal growth source. We also reviewed documentation of the following actions taken by university staff to address IEQ issues: (1) identifying and remediating a dime-sized spot of suspected mold growth; (2) insulating pipes to prevent condensation; (3) replacing water damaged ceiling tiles; (4) professionally cleaning carpeting and fabric-covered furniture in the basement; (5) cleaning mold and mildew in the basement and repainting basement walls; and (6) adding additional portable dehumidifiers throughout the building.

Our objectives for this evaluation were to answer the following questions:

1. Does the building have a widespread mold problem or other IEQ problem that may be associated with employee health?
2. Are employees reporting work-related health effects that are known to be associated with mold exposures or other aspects of IEQ?

## Building Walk-through Survey

We toured the building and visually surveyed all offices, labs, classrooms, conference rooms, therapy rooms, the sound booth room, and storage/custodial rooms to look for evidence of past or current water infiltration or water damage. We also used the following instruments to check for the presence of moisture or water damage:

- A FLIR TG165 imaging infrared thermometer. We used this device to identify potential moist or water-damaged areas in walls, floors, and ceilings. It uses infrared thermal imaging technology to depict temperature differences between dry and wet materials, even in areas that are not readily visible, such as behind drywall or above a suspended ceiling.
- A TRAMEX Moisture Encounter Plus® nondestructive moisture meter. This hand-held direct-reading device can measure the interior moisture levels. We used the moisture meter to confirm that suspected moist areas identified by the infrared thermometer were actually moist.

We measured carbon dioxide, temperature, and relative humidity (RH) over 2 days with calibrated TSI Q-Trak™ Indoor Air Quality monitors. We selected rooms in the basement, first, second, and third floors because these were served by different ventilation systems. We measured indoor and outdoor carbon dioxide concentrations to determine if indoor occupied spaces were adequately ventilated [ANSI/ASHRAE 2013a]. We measured temperature and RH because they can affect how employees perceive their indoor environment [ANSI/ASHRAE 2013b]. Excessive humidity can also promote the growth of microorganisms and dust mites.

We visually inspected the exterior and interior of unit ventilators. We checked if the unit ventilator was operational, the type and condition of the air filters, whether the outdoor air damper, if present, was in the opened or closed position, and if furniture or school supplies interfered with the flow of room air through the ventilator. We also checked the operation of several window air conditioners on the third floor.

During our walk-through survey we saw peeling and chipped paint on the walls and ceilings in several storage rooms. Considering the age of the building and the condition of the painted surfaces, we collected paint chip samples and tested them for lead. We tested for lead in paint chips using 3M™ Lead Check® swabs. The limit of detection for these swabs is 600 parts per million (ppm).

## Employee Interviews and Medical Record Review

Before the site visit, we reviewed medical records provided by the university for the specific employees who had filed workers' compensation claims because of mold exposure.

We interviewed all available employees and graduate assistants in the building in person or by telephone. Former employees identified by department staff as having had health problems were also interviewed. Employees were asked about medical conditions or symptoms they thought were related to the school environment. We took a medical history to identify unrecognized occupational illness. Medical records were requested if employees reported seeing a physician for health issues that they attributed to the school environment. We did not request medical records for health problems we determined were not related to the building, such as hair loss.

# Results

## Environmental Assessment

### Building Walk-through Survey

Nearly all of the rooms were carpeted, and employees kept most interior hallway doors closed during the workday because of patient privacy and equipment security concerns. Door vents in first and second floor offices were covered with solid wood panels because of patient and student privacy concerns. These doors were closed and locked after work and on weekends. In response to high humidity levels in the building (above 65%) portable dehumidifiers had been placed in the building.

We saw large quantities of materials stored in several rooms. These materials included old journals, unused furniture, bulk paper and cleaning products, and educational or therapy materials. In some instances the stored materials made egress from the room difficult. Material storage can make it difficult for employees to see areas of water damage, and could be a source of dust, which can irritate skin and mucous membranes. Paper is also a potential substrate for microbial growth because of the poor humidity control in the building. We saw scented air fresheners in the bathrooms. These air fresheners can be a cause or irritation or allergy in some employees. Employees with asthma reported that these products had elicited asthma symptoms. We saw cobwebs and dust in offices, suggesting that general housekeeping could be improved. Finally, we observed that most of the vacuums were not equipped with high efficiency particulate air filters.

### Mold and Moisture Assessment

We looked in all rooms for indicators of mold or moisture. We did not observe any widespread mold or moisture problems. We identified two isolated locations of potential moisture. In the library closet, which was previously a bathroom, we saw probable mold growth in the medicine cabinet and on the back of the door to the closet. Recently, mold had been removed from the ceiling and the walls had been repainted. We found a damp area about 1 square foot in size on a plaster wall in the northwest corner of room 209 on the second floor. The paint had bubbled, but we did not see evidence of mold contamination.

### Temperature, Relative Humidity, and Carbon Dioxide

Table 1 summarizes the temperature and RH levels measured in the building over 24 hours, beginning the afternoon of July 27, 2015.

Table 1. Temperature and relative humidity levels in the building, July 27–28, 2015*

| Location | Temperature, °F | | RH, percent | |
|---|---|---|---|---|
| | Minimum | Maximum | Minimum | Maximum |
| Basement lab | 70 | 73 | 35 | 60 |
| Conference room | 72 | 79 | 44 | 69 |
| Corridor, near main entrance, first floor | 72 | 77 | 42 | 65 |
| Lab, in the sound booth room | 71 | 75 | 38 | 59 |
| Office, near main entrance, first floor | 68 | 73 | 48 | 80 |
| Room 111 | 71 | 75 | 43 | 66 |
| Room 112 | 72 | 85 | 43 | 78 |
| Room 130 | 72 | 76 | 49 | 73 |
| Room 203 | 74 | 78 | 47 | 75 |
| Room 208 | 72 | 84 | 40 | 63 |
| Room 209 | 66 | 75 | 43 | 76 |
| Room 217 | 65 | 74 | No data | No data |
| Room 301 | 70 | 76 | 47 | 67 |

*Measurements collected for approximately 24 hours, beginning around 5:00 p.m. on July 27, 2015.

Some temperatures were not within recommended thermal comfort guidelines for the summer season of 75°F to 80.5°F [ANSI/ASHRAE 2013b]. Most maximum RH levels were above 65%, which is the recommended upper limit for indoor RH [ANSI/ASHRAE 2013]. Excessive humidity can promote the growth of microorganisms and dust mites.

Carbon dioxide concentrations were about 450 ppm to 720 ppm indoors. The outdoor concentration was around 380 ppm. Carbon dioxide is a normal part of exhaled breath. Its concentration can be used to determine if enough outdoor air is being supplied to keep odors to an acceptable level. Indoor carbon dioxide concentrations no greater than 700 ppm above outdoor carbon dioxide concentrations will satisfy about 80% of occupants [ANSI/ASHRAE 2013a]. Carbon dioxide concentrations were within recommended guidelines during this evaluation. However, the building was sparsely occupied. Therefore, comparing indoor and outdoor carbon dioxide concentrations may not be a good indicator of ventilation adequacy in this instance. Carbon dioxide concentrations measured during the academic term, when more students and patients are in the building, would be a better indicator of ventilation adequacy.

## Ventilation

The building did not have a central forced-air heating or cooling system. Instead, nearly all offices, corridors, and meeting rooms had unit ventilators along the building's exterior walls. On the first and second floors chilled or hot water was piped to these unit ventilators to provide cooling or heating. In some first and second floor rooms only heat was provided via perimeter hot water radiators. Unit ventilators on the third floor provided heat, and cooling was provided by window air-conditioning units. Two ductless split air-conditioning units provided cooling for basement offices, meeting rooms, and sound booth testing areas.

None of the unit ventilators in the building was designed to bring outdoor air into the building. Although the exterior windows in the building were operable we did not see open windows during our evaluation, and signs were posted in the building asking employees not to open windows. Some window air conditioners on the third floor had small (credit-card sized) manually operated outdoor air dampers, but some of these dampers were closed or did not work.

We selected two unit ventilators to visually inspect the air filters and condensate drain pans. The air filters appeared clean and properly installed, and the condensate drain pans were dry and clean. During our walk-through survey we noted that the fans on 15 of the 25 unit ventilators on the first and second floors were running on either low, medium, or high speed; the fans on the remaining 10 air handling units were either turned off or the vents blocked. The air filters on unit ventilators were replaced quarterly.

Of the seven dehumidifiers in the building three were plumbed to drains. The remaining four dehumidifiers had to be manually emptied, sometimes more than once per day according to employees. The reusable air filters and evaporator coils on the two ductless split air-conditioning units in the basement were cleaned each summer.

### Lead

We detected lead in paint chip samples collected from the walls in the former shower rooms on the first, second, and third floors. No lead was detected in a paint chip sample taken in a former bathroom on the first floor. These areas were locked and used to store custodial supplies or excess/unused furniture and office equipment. Employees infrequently entered these locked rooms.

## Medical Assessment

### Interviews and Medical Records Review

We interviewed all 12 employees and 7 of 13 graduate assistants. We also interviewed two former employees. The length of employment at the university or the time as a graduate assistant ranged from less than 1 year to 32 years. Of the 21 interviewed employees, six reported no symptoms or medical conditions related to the school environment, and 15 reported symptoms or medical conditions that they felt were or might be related to the school environment. The most common reported symptoms thought to be related to the school environment were eye irritation (8), runny or stuffy nose (6), and headache (5). Symptoms or conditions reported by fewer than five people included fatigue, sore or dry throat, post-nasal drip, frequent upper respiratory or sinus infections, skin problems, cough, hives, fibromyalgia, chronic fatigue syndrome, chronic hives, and urinary tract infection.

We asked employees if they ever had asthma, hay fever, or eczema so we could estimate the prevalence of atopy (the predisposition toward allergic diseases). Over half (11 of 19) of the current employees reported at least one of these conditions, suggesting they are atopic. Five of eight employees who reported typical allergic symptoms associated with the building were atopic, compared to six of 11 who did not report allergic symptoms related to the building. Three employees reported asthma diagnosed before beginning work at the university, and two of the three reported increased inhaler use and worsening of symptoms at work.

We reviewed university medical records for four current employees or graduate assistants and one former employee. Medical records for the two employees who reported worsening of asthma at work did document treatment for asthma exacerbations reported while at work. Medical records reviewed for the other three employees did not document any work-related illness. Medical records were requested for one employee who reported a fungal lung infection; review of the records documented viral rather than fungal respiratory illness.

A recurring topic in our interviews was poor communication between building occupants, facilities maintenance staff, and university managers. Many people reported to us that they believed their concerns were not taken seriously, and mentioned that they were treated as "complainers." Some interviewees were not aware of what, if anything, was being done to improve building conditions.

# Discussion

No airborne exposure standards specific to the nonindustrial work environment exist. Likewise, no exposure guidelines for mold (or other microbes) in air exist, so it is not possible to distinguish between "safe" and "unsafe" levels of exposure. Therefore, measuring indoor environmental contaminants, such as mold, has seldom proved helpful in determining the cause of symptoms. However, we often measure ventilation and comfort indicators, such as carbon dioxide, temperature, and RH, to provide information relative to the functioning and control of heating, ventilating, and air-conditioning systems. For this reason, we recommend stopping sampling for mold and redirecting resources toward improving the ventilation systems.

Inadequate ventilation is one of the most common deficiencies we have found over many years of health hazard evaluations in nonindustrial indoor environments. Inadequate ventilation may be due to the improper operation and maintenance of ventilation systems, or from an ineffective ventilation system design as is the case with this building. For example, some temperatures in occupied spaces that we checked were not within the ANSI/ASHRAE recommended thermal comfort guidelines and the RH levels were not kept below 65%. Additionally, none of the unit ventilators, and few of the window air-conditioning units, were designed to bring outdoor air into the building. Although relatively low indoor $CO_2$ concentrations suggested ventilation adequacy, this finding could be explained by the sparse occupancy; it may not reflect the design and operation of the ventilation systems under all conditions. An analysis of the published scientific literature showed that nonspecific symptoms such as headache, fatigue, and mucous membrane irritation increase as ventilation rates decrease [Fisk et al. 2009]. Studies in schools and office buildings have found decreased illness absence with increased ventilation rates [Milton et al. 2000; Shendell et al. 2004; Mendell et al. 2013]. Thus, improving heating, ventilating, and air-conditioning operation and maintenance and increasing ventilation rates can improve symptoms without ever identifying any specific cause-effect relationships. We believe similar benefits would occur if ventilation is improved in this building.

The abundance of paper in some rooms could generate and accumulate dust, which can be irritating to skin and mucous membranes. The clutter may also hinder housekeeping and can provide a substrate for microbial growth when humidity is high.

Exposure to microbes is not unique to the indoor environment. No environment, indoors or outdoors, is completely free from microbes, not even a surgical operating room. Microbes present in indoor air that are relevant to health include pollen and plant spores coming from outdoors; bacteria, fungi, algae, and protozoa from both indoors and outdoors; and microbes and allergens spread from person to person, and from person to environment (including pet dander) [WHO 2009]. Dampness and inadequate ventilation lead to the growth of microbes, and degrade building materials [WHO 2009]. Many buildings have episodes of water or moisture intrusion. Moisture intrusion, along with nutrient sources such as building materials or furnishings, allows mold and other microbes to grow indoors, so it is important to keep the building interior and furnishings dry [NIOSH 2012]. Remediation of microbial contamination may improve IEQ conditions even though a specific cause-effect relationship is not determined.

The type and severity of symptoms related to mold exposure in the indoor environment depends on the extent of the mold present, the extent of the individual's exposure, and the susceptibility of the individual (for example, whether he or she has preexisting allergies or asthma). Sufficient epidemiological evidence indicates an association between occupancy in damp buildings and upper and lower respiratory tract symptoms (including cough, wheeze, and shortness of breath), respiratory infections (such as colds), asthma, exacerbation of asthma, bronchitis, allergic rhinitis, and eczema [WHO 2009; Mendell et al. 2011]. Clinical evidence shows that exposure to mold and other microbial agents in damp buildings is associated with hypersensitivity pneumonitis (an allergic reaction in the lungs to certain inhaled dusts, microbes, or chemicals lungs) [WHO 2009]. The specific agents (i.e., mold, bacteria, or other agents present in damp buildings) causing health problems have not been identified [WHO 2009; Mendell et al. 2011].

People with weakened immune systems (those with diabetes, on chronic systemic steroid therapy, with cancer, or acquired immune deficiency syndrome, among other things) may be more vulnerable to invasive infections by molds. Invasive infections differ from common superficial infections like athlete's foot or ringworm. While some individuals may get infected after indoor exposure, it has not been shown to be more frequent in those who occupy damp buildings. Certain molds that are found everywhere may cause infection in a suitable susceptible host. These invasive fungal infections are called "opportunistic." No studies link these opportunistic infections to mold in the indoor environment [WHO 2009]. Healthy individuals are usually not vulnerable to infections from airborne mold exposure, and no school employees had an opportunistic fungal infection.

Some of the symptoms employees reported, such as runny or stuffy nose, cough, eye irritation, and sore throat, could be related to past incidents of water intrusion with resultant microbial growth. At the time of our evaluation, one room had suspected mold growth. Although isolated areas of fungal growth could be related to symptoms, the lack of adequate ventilation can also result in these nonspecific symptoms. During our evaluation, ventilation deficiencies were almost ubiquitous throughout the building, while past water damage was isolated and limited and we saw only one room with visible mold growth. Therefore, poor ventilation would be more likely to explain the occurrence of symptoms than water damage and mold growth. However, because of the nonspecific nature of these symptoms (meaning they can be caused by many things), and their commonality in the general population, a link to any particular exposure in the building cannot be ruled out.

Of the general population, 86%–95% have one or more common symptoms during any given 2- to 4-week period, and the average adult reports a minimum of one symptom every 4–6 days [Barsky and Borus 1995]. Table 2 lists the general population prevalences of many of the symptoms reported by school employees. Women, who comprised the majority of the school's employees, were more likely to report symptoms in all of the studies listed in Table 4. In addition, the average adult has two to three upper respiratory infections per year [Benninger et al. 2003]. According to the National Health Interview Survey, 12% of U.S. adults reported physician-diagnosed sinusitis in 2012 [CDC 2014]. Women were more likely to be diagnosed with sinusitis (15% compared to 9% in men) [CDC 2014].

Table 2. General population prevalence of symptoms similar to those reported by university employees (by population)

| | Clustered random sample of households Australia | General medical practices in the United Kingdom | Representative sample of general population of New Zealand |
|---|---|---|---|
| Participants | n = 3,016* | n = 2,474† | n = 1,000‡ |
| Time frame | 14 days | 14 days | 7 days |
| Number of symptoms asked about | 12 | 25 | 46 |
| Percent reporting at least one symptom | 80 | > 75 | 89 |
| Number of symptoms reported, mean (range) | Not reported | 3.6 (0–22) | 5 (0–36) |
| Symptoms similar to those reported at this school (%) | Stuffy nose (46)<br>Headache (33)<br>Unusually tired (30)<br>Cough (26)<br>Dry, itchy, or irritated eyes (25)<br>Dry or sore throat (22)<br>Skin rash (12) | Tired/run down (41)<br>Headache (39)<br>Sore throat (19)<br>Cough (18) | Fatigue (36)<br>Headache (35)<br>Congested or runny nose (34)<br>Cough (28) |

*Reference: Heyworth and McCaul 2001

†Reference: McAteer et al. 2011

‡Reference: Petrie et al. 2014

The U.S. Environmental Protection Agency (EPA) conducted a systematic survey of 100 randomly selected office buildings without known IEQ complaints in the United States to develop baseline data about U.S. office buildings [Brightman et al. 2008]. The National Institute for Occupational Safety and Health (NIOSH) conducted a similar study of 80 buildings with IEQ complaints [Malkin et al. 1996]. Occupants in both studies reported work-related symptoms. The rank order of symptoms was the same, but rates were significantly higher in the buildings with IEQ complaints. The most common work-related symptoms reported in both studies were dry, itching, or irritated eyes; unusual tiredness or fatigue; headache; tension or irritability; pain in back, neck, and shoulders; stuffy or runny nose, or sinus congestion; sneezing; sore or dry throat; and difficulty remembering things or concentrating. Of the employees in the randomly selected buildings, 45% reported at least one work-related symptom. These common symptoms in the general population and in buildings are also among the most common symptoms reported by this school's employees.

Two employees reported worsening of pre-existing asthma, and over half of the interviewed employees reported asthma, hay fever, or eczema, meaning they are atopic. Atopic individuals are at increased risk of developing allergy to certain substances, among them being "typical" allergens like grasses, pollen, cats, dogs, and dust mites. In addition to allergens present in the building from outdoor air, or their proliferation on building materials, some allergens can be carried in on employees, students, and visitors. The most common of these are cat and dog allergens, which can be an unrecognized source of allergic upper and lower respiratory and skin symptoms among employees and students.

Many medical issues mentioned by interviewed employees, such as hair loss, hives, fibromyalgia, and chronic fatigue syndrome, were unrelated to each other or to the building.

# Conclusions

We did not see evidence of a widespread, current mold problem in the building. We did find an isolated instance of probable mold growth in a library closet and evidence of past water damage in several areas. In addition, we measured high humidity levels, which can lead to growth of mold and other microbes, and proliferation of dust mites. We also identified several correctable problems, in particular, the inadequate ventilation. Many of the symptoms employees reported, such as sinus problems and headaches, have been associated with damp buildings or inadequate ventilation but are common in the general population. We found no evidence that other health problems reported by some individuals, such as hives and hair loss, among other things, were related to working in the building.

# Recommendations

On the basis of our findings, we recommend the actions listed below to create a more healthful workplace. We encourage the university to form a labor-management health and safety committee to discuss the recommendations in this report and develop an action plan. Those involved in the work can best set priorities and assess the feasibility of our recommendations for the specific situation at the school.

Our recommendations are based on the hierarchy of controls approach. This approach groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or feasible, administrative measures and/or personal protective equipment may be needed.

## Engineering Controls

Engineering controls reduce exposures to employees by removing the hazard from the process or placing a barrier between the hazard and the employee. Engineering controls are very effective at protecting employees without placing primary responsibility of implementation on the employee.

1. Make renovation of the ventilation systems a top priority to meet current ANSI/ASHRAE guidelines for maintaining acceptable IEQ. Consult with a licensed professional mechanical engineer who has experience in the design of heating, ventilating, and air-conditioning systems.
2. Operate the air-conditioning units at all times during hot and humid weather.
3. Plumb all dehumidifiers to drains so they can operate continuously.

## Administrative Controls

Administrative controls are management-dictated work practices and policies to reduce or prevent exposures to workplace hazards. The effectiveness of administrative changes in work practices for controlling workplace hazards is dependent on management commitment and employee acceptance. Regular monitoring and reinforcement is necessary to ensure that control policies and procedures are not circumvented in the name of convenience or production.

1. Stop sampling for mold in air.
2. Keep hallway doors open as much as possible, closing them only when privately talking to a patient or student. Alternatively, use designated rooms for private discussions so that more hallway office doors can be kept open.
3. Open hallway doors after normal working hours and on weekends to improve air circulation in the building. If privacy or security concerns require closing or locking doors, consider reopening the closed door vents or installing convertible vents.
4. Consider minimizing the use of carpet and upholstered furniture. Porous materials are more difficult to clean than smooth, nonporous surfaces and can harbor microbes and dust mites.
5. Implement an IEQ management plan for the university. Select an IEQ manager or administrator with clearly defined responsibilities, authority, and resources. This individual should have a good understanding of the building's structure and function and should be able to effectively communicate with occupants. This proactive approach can help prevent IEQ problems from occurring. Although comprehensive

regulatory standards specific to IEQ have not been established, guidelines have been developed by organizations such as ASHRAE, NIOSH, and the EPA. The EPA has several publications on IEQ, including the IAQ Tools for Schools Action Kit at http://www.epa.gov/iaq/schools/toolkit.html. The Tools for Schools document discusses IEQ in some detail and includes information on common problems, investigative techniques, and solutions to specific problems. Additional resources include the EPA Healthy School Environments Assessment Tool, available at http://www.epa.gov/schools/, which helps school districts establish and manage comprehensive school facility self-assessment programs. It contains an environmental health and safety checklist and is designed to be easily customized to reflect state and local requirements and policies. The basic elements of a good IEQ plan include the following:

- Properly operating and maintaining the heating, ventilating, and air-conditioning equipment, including accommodating staff who work during hours when the air handling system(s) is routinely cycled off, to ensure that adequate ventilation is provided
- Overseeing the activities of occupants and contractors that affect IEQ (e.g., housekeeping, pest control, maintenance, food preparation)
- Maintaining and ensuring effective and timely communication with occupants regarding IEQ
- Educating building occupants and contractors about their responsibilities in relation to IEQ
- Proactively identifying and managing projects that may affect IEQ (e.g., redecoration, renovation, relocation of personnel)
- Designating an employee representative who can speak for other employees and can assist with communication

Information on selecting IEQ consultants is available from the American Industrial Hygiene Association *Guidelines for Selecting an Indoor Air Quality Consultant* available at https://www.aiha.org/about-aiha/Press/ConsumerBrochures/Guidelines%20for%20Selecting%20An%20Indoor%20Air%20Quality%20Consultant.pdf.

6. Include managers and employees on the health and safety committee.
7. Remove all scented air fresheners from common areas. Consider instituting a no-fragrances policy.
8. Use vacuums with high-efficiency particulate air filters when cleaning the building.
9. Encourage employees with health concerns to seek evaluation and care from a physician who is residency trained and board certified in occupational medicine and is familiar with the types of exposures employees might have had and their health effects. Occupational medicine physicians can be found through a variety of sources, including the Association of Occupational and Environmental Clinics, at http://www.aoec.org/, and the American College of Occupational and Environmental Medicine, at http://www.acoem.org/. It may be useful to provide the physician with a copy of this report.

10. Implement a formal system for reporting building concerns to the facilities maintenance manager. This system can be paper or electronic and should include a mechanism to let staff know when and how the problem is fixed.

11. Hire a qualified lead assessment professional to evaluate the building for lead-based paint or lead in dust in locations where paint is peeling or chipping. Take potential lead exposure into account when doing any construction or renovation in the building and ensure that employees are protected from exposure to lead.

12. Limit access to areas with peeling or flaking paint until it has been appropriately evaluated for lead content and remediated.

13. Ask employees to report any areas of peeling or chipping paint to facilities staff.

# References


ANSI/ASHRAE [2013a]. Ventilation for acceptable indoor air quality. American National Standards Institute/ASHRAE standard 62.1-2013. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

ANSI/ASHRAE [2013b]. Thermal environmental conditions for human occupancy. American National Standards Institute/ASHRAE standard 55-2013. Atlanta, GA: American Society for Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

Barsky AJ, Borus JF [1995]. Somatization and medicalization in the era of managed care. JAMA *274*(24):1931–1934.

Benninger MS, Ferguson BJ, Hadley JA, Hamilos DL, Jacobs M, Kennedy DW, Lanza DC, Marple BF, Osguthorpe JD, Stankiewicz JA, Anon J, Denneny J, Emanuel I, Levine H [2003]. Adult chronic rhinosinusitis: definitions, diagnosis, epidemiology, and pathophysiology. Otolayngol Head Neck Surg *129*(3 Suppl):S1–S32.

Brightman HS, Milton DK, Wypij D, Burge HA, Spengler JD [2008]. Evaluating building-related symptoms using the US EPA BASE study results. Indoor Air *18*(4):335–345.

CDC (Centers for Disease Control and Prevention) [2014]. Summary health statistics for U.S. adults: National Health Interview Survey, 2012. [http://www.cdc.gov/nchs/data/series/sr_10/sr10_260.pdf]. Date accessed: March 2016.

CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Fisk WJ, Mirer AG, Mendell MJ [2009]. Quantitative relationship of sick building syndrome symptoms with ventilation rates. Indoor Air *19*(2):159–165.

Heyworth J, McCaul K [2001]. Prevalence of non-specific health symptoms in South Australia. Int J Environ Health Res *11*(4):291–298.

Malkin R, Wilcox T, Sieber WK [1996]. The National Institute for Occupational Safety and Health indoor environmental evaluation experience. Part two: symptom prevalence. Appl Occup Environ Hyg *11*(6):540–545.

McAteer A, Elliott AM, Hannaford PC [2011]. Ascertaining the size of the symptom iceberg in a UK-wide community-based survey. Br J Gen Pract *61*(582):e1–11, http://dx.doi.org/10.3399/bjgp11X548910.

Mendell MJ, Eliseeva EA, Davies MM, Spears M, Lobscheid A, Fisk WJ, Apte MG [2013]. Association of classroom ventilation with reduced illness absence: a prospective study in California elementary schools. Indoor Air *23*(6):515–528, http://dx.doi.org/10.1111/ina.12042.

Mendell MJ, Mirer AG, Cheung K, Tong M, Douwes J [2011]. Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. Environ Health Perspect *119*(6):748–756, http://dx.doi.org/10.1289/ehp.1002410.

Milton DK, Glencross PM, Walters MD [2000]. Risk of sick leave associated with outdoor air supply rate, humidification, and occupant complaints. Indoor Air *10*(4):212–221.

NIOSH [2012]. NIOSH alert: preventing occupational respiratory disease from exposures caused by dampness in office buildings, schools, and other nonindustrial buildings. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2013-102.

Petrie KJ, Faasse K, Crichton F, Grey A [2014]. How common are symptoms? Evidence from a New Zealand national telephone survey. BMJ Open *4*(6):e005374, http://dx.doi.org/10.1136/bmjopen-2014-005374.

Shendell DG, Prill R, Fisk WJ, Apte MG, Blake D, Faulkner D [2004]. Associations between classroom $CO_2$ concentrations and student attendance in Washington and Idaho. Indoor Air *14*(5):333–341.

WHO [2009]. WHO guidelines for indoor air quality: dampness and mould. Geneva, Switzerland: World Health Organization. [http://www.euro.who.int/document/e92645.pdf]. Date accessed: March 2016.

Keywords: North American Industry Classification System 611310 (Colleges, Universities, and Professional Schools), South Dakota, mold, indoor environmental quality, IEQ, ventilation, humidity

This page left intentionally blank

The Health Hazard Evaluation Program investigates possible health hazards in the workplace under the authority of the Occupational Safety and Health Act of 1970 (29 U.S.C. § 669(a)(6)). The Health Hazard Evaluation Program also provides, upon request, technical assistance to federal, state, and local agencies to investigate occupational health hazards and to prevent occupational disease or injury. Regulations guiding the Program can be found in Title 42, Code of Federal Regulations, Part 85; Requests for Health Hazard Evaluations (42 CFR Part 85).

## Disclaimer

The recommendations in this report are made on the basis of the findings at the workplace evaluated and may not be applicable to other workplaces.

Mention of any company or product in this report does not constitute endorsement by NIOSH.

Citations to Web sites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. NIOSH is not responsible for the content of these Web sites. All Web addresses referenced in this document were accessible as of the publication date.

## Acknowledgments

Desktop Publisher: Shawna Watts
Editor: Ellen Galloway
Logistics: Donnie Booher, Kevin Moore

## Availability of Report



This report is available at http://www.cdc.gov/niosh/hhe/reports/pdfs/2015-0118-3249.pdf.

**Recommended citation for this report:**
NIOSH [2016]. Health hazard evaluation report: evaluation of indoor environmental quality and health concerns in a public university. By Page E, Broadwater K, Burr G. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2015-0118-3249.