INDOOR AIR QUALITY ASSESSMENT

Furnace Brook Middle School
500 Furnace Street
Marshfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of a parent, an indoor air quality assessment was done at the Furnace Brook Middle School in Marshfield, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA).

On November 12, 1999, a visit was made to this school by Cory Holmes, Environmental Analyst, ER/IAQ, BEHA to conduct an indoor air quality assessment. Mr. Holmes was accompanied by Suzan Donahue, Research Assistant, BEHA. This request was prompted by indoor air quality issues concerning renovations in the school.

The school is a two-story brick building originally built in the late 1950s and formerly served as an elementary school. The building houses 6th and 7th graders and is currently undergoing renovations to accommodate 8th graders, which will occupy the building during the 2000-2001 school year. Renovations include a new addition, renovation of the auditorium and of existing classrooms. The second floor contains general classrooms and a computer room. The first floor consists of general classrooms, media center, computer room, choral room, band room, gymnasium, cafeteria and office space.

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with the Mannix, TH Pen PTH8708 Thermo-Hygrometer. Screening for total volatile organic compounds (TVOCs) was conducted using an HNU Systems, Photo Ionization Detector (PID). Samples for TVOCs were taken throughout the building with a focus on areas that would most likely be

impacted by renovation activities. Outdoor background total volatile organic compound measurements were taken for comparison to indoor levels.

Results

The school has a student population of 720 and a staff of approximately 80. Tests were taken under normal operating conditions. Test results appear in Tables 1-6.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 ppm in thirty-five of the forty-two areas surveyed, which is indicative of an overall ventilation problem in the school. However, it is important to note that a number of areas had newly installed ventilation systems that had not been activated and calibrated at the time of the assessment. Of note were the language conference room and the choral room, which had levels of carbon dioxide in excess of 800 ppm without occupancy during the air monitoring, indicating little or no air exchange. It is also noted that areas in which carbon dioxide levels were below 800 ppm had open windows or were sparsely populated during the assessment, which can greatly reduce carbon dioxide levels. Fresh air in classrooms is supplied by a mechanical unit ventilator (univent) system (see Figure 1). The majority of univents in non-renovated classrooms were operating during the assessment.

Mechanical exhaust ventilation is provided by ceiling-mounted intake grills connected to ductwork. As with many of the univents, a number of exhaust vents were not operating and were in the process of being activated subsequent to renovations. In order to have proper ventilation with a univent and exhaust system, these systems must be balanced

to provide an adequate amount of fresh air to the interior of a room while removing stale air. A ventilation engineer should balance this system once renovation activities are complete and the system is fully operational.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself at levels measured in this building. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this occurs a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings were within a range of 73^0F to 81^0F, which is close to BEHA's recommended comfort guidelines. However, a number of areas were above or

close to the higher end of the comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{0}F to 78 ^{0}F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Heat complaints in the language conference room and in the computer room were reported to BEHA staff. As mentioned previously, mechanical ventilation systems were not fully operational at the time of the assessment, which makes it difficult to control for temperature.

The relative humidity in this building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 14 to 30 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A number of rooms had water-stained ceiling tiles, which are evidence of historic roof or plumbing leaks. Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered, and repaired. A water-stained ceiling tile was noted in the computer room with a dark stain, which may be possible mold growth. Mold can be a respiratory irritant for certain sensitive individuals.

Several classrooms had a number of plants. Moistened plant soil and drip pans can serve as a source of mold growth. Several classrooms had flowering plants on top of univents (see Picture 1). Plants should be equipped with drip pans and located away from univents to prevent the aerosolization of dirt, pollen or mold.

Water coolers were placed on carpets in the 1st and 2nd floor teachers' lounges. To avoid water damage to carpeting and/or potential mold growth, a water-resistant material such as plastic or rubber matting should be installed beneath water coolers.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. TVOCs within this building were found to be equal to or below levels measured outdoors in all areas surveyed. While there were noticeable odors from new carpet, new furnishings, painting, etc., it would seem that any VOCs, which may have been present, have dissipated leaving only nuisance odors behind.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

The teacher's lounge contains a photocopier. Excess heat, volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Local exhaust ventilation should be activated while equipment is in use to help reduce excess heat and odors in this room.

Renovations

At the time of the assessment, renovations were being conducted in the old classroom wing and in the auditorium. All doors to classrooms and the auditorium were shut. Patches of construction dust were noted on hallway floors, which indicates inadequate containment of renovation dust and debris around these doors. BEHA staff recommended that these doors be covered with plastic sheeting and duct tape to make this seal airtight to prevent dust penetration into occupied areas of the school.

The construction zone in the old classroom wing was separated from the occupied area of the school by temporary wooden doors. Doors to this area were chained and padlocked to prevent entry into the renovation area, however, these doors are not airtight and the area was not properly sealed off from the occupied areas of the building. Holes were bored through these doors in order to chain and padlock the doors shut (see Picture 2). Airflow into the hallway from the construction site was noted through these holes. BEHA staff also recommended that these holes be sealed with plastic and duct tape to prevent the possible egress of construction material into other areas of the school.

During the assessment roof work was being conducted over the old portion of the building (see Picture 3). Roofing glues and sealers can contain volatile organic compounds (VOCs), which can off-gas during application and for several days after installation, depending on weather conditions. Off-gassing VOCs from roof glues and sealers can be entrained through open windows or univent fresh air intakes (operating or otherwise). VOCs can be irritating to the eyes, nose and throat. VOC exposure to building occupants resulting from roof work should be prevented. Precautions should be taken to prevent the egress of odors from these materials into occupied areas of the school. Primary among the precautions that should be used is sealing spaces around doors, fresh air intakes, ventilation ducts and utility holes in ceilings, floors and walls.

Conclusions/Recommendations

Renovations

The following recommendations should serve to decrease the impact of renovation-produced pollutants while this building is occupied. We suggest that these steps be taken on any renovation project within a public building. BEHA recommendations to maintain indoor air quality during renovations are universal and should be applied during subsequent phases of renovation.

1. Establish communications between all parties involved with building renovations to prevent potential IAQ problems. Develop a forum for occupants to express concerns about renovations as well as a program to resolve IAQ issues.
2. Develop a notification system for building occupants immediately adjacent to construction activities to report construction/renovation related and/or dust problems to the building administrator. Have these concerns relayed to the contractor in a manner to allow for a timely remediation of the problem.
3. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.
4. Disseminate scheduling itinerary to all affected parties. This can be done in the form of meetings, newsletters or weekly bulletins.
5. Obtain Material Safety Data Sheets (MSDS) for all construction materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).

6. Consult MSDS' for any material applied to the effected area during renovation including any sealant, carpet adhesive, tile mastic, flooring and roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.
7. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the building's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).
8. If possible, relocate susceptible persons and those with pre-existing medical conditions (i.e. hypersensitivity, asthma) away from areas of renovations.
9. Implement prudent housekeeping and work site practices to minimize exposure to renovation pollutants. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.
10. Close windows adjacent to construction activities to prevent unfiltered air from entering the building.
11. Consider changing univent filters more regularly in areas adjacent to the construction zone. Examine the feasibility of acquiring more efficient filters for these units.

General Indoor Air Quality

In view of the findings at the time of our inspection, the following recommendations are made to improve general indoor air quality:

1. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room and make univent repairs as needed. Check fresh air intakes for repair and increase the percentage of fresh air intake if necessary.
2. Once the unit ventilator and exhaust systems are operational, the systems should be balanced. Operate univents and exhaust ventilation while classrooms are occupied.
3. Remove all obstructions from univents and mechanical exhaust vents to facilitate airflow.
4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
5. Repair any existing water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
6. Move plants away from univents in classrooms. Ensure drip pans are placed underneath plants in classrooms. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
7. Acquire current Material Safety Data Sheets for all products that are used in the building that contain hazardous materials, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

8. Store chemicals and cleaning products properly and out of the reach of students.

References

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1995. IAQ Guidelines for Occupied Buildings Under Construction. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Figure 1 **Unit Ventilator (Univent)**