INDOOR AIR QUALITY ASSESSMENT

Wakefield Memorial High School
60 Farm Street
Wakefield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
December 2012

Background/Introduction

At the request of Mr. Peter Evangelista, Facilities Director, Wakefield Public Schools, the Massachusetts Department of Public Health's (MDPH), Bureau of Environmental Health (BEH) conducted an indoor air quality (IAQ) assessment at the Wakefield Memorial High School (WMHS), 60 Farm Street, Wakefield, Massachusetts. On November 1, 2012, a visit was made to the WMHS by Sharon Lee, Environmental Analyst/Inspector, Cory Holmes, Environmental Analyst/Regional Inspector and Ruth Alfasso, Environmental Engineer/Inspector for BEH's IAQ Program. The request was in response to general concerns regarding IAQ and concerns regarding accreditation due to facility issues. The WMHS was put on "warning" status by the New England Association of Schools & Colleges (NEASC) following a comprehensive review. According to the NEASC report "serious" concerns, as pertaining to building conditions included:

- Ongoing roof leaks and mold issues;
- Outdated and inconsistent HVAC system;
- Dirty ventilation ducts throughout the school;
- Broken glass in windows and doorways;
- Frayed and dirty carpeting;
- Poor condition of floor tiles;
- Poor air quality in locker rooms; and
- General lack of cleanliness throughout the facility (NEASC, 2012).

The WMHS is a brick and cement-slab structure originally built in 1960 and significantly renovated and added to in 1974. The building has a lower floor, an upper floor and a third floor with a smaller footprint. The school contains general classrooms, science classrooms, art classrooms, home economics and shop classrooms, a gym and field house, two cafeterias, a library and a variety of offices. Windows throughout the school are openable.

The BEH/IAQ program previously visited this building in 1996 and 1998. IAQ reports were issued for each of those visits detailing conditions observed at that time and are available on request.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. BEH/IAQ staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 970 students in ninth through twelfth grade with approximately 90 staff members. Tests were taken during normal operations, and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in 58 of 122 areas tested, indicating poor air exchange in about half of the areas surveyed at the time of assessment. In many areas, ventilation equipment was found inoperable or deactivated, therefore no means of mechanical ventilation was being provided to these areas at the time of testing. It is also important to note that several areas had open windows or were empty/sparsely populated, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to increase with higher occupancy and windows closed.

Fresh air to classrooms along exterior walls is supplied by unit ventilator (univent) systems (Picture 1). A univent draws air from the outdoors through a fresh air intake located on the exterior wall of the building (Picture 2). Return air from the classroom is drawn through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. As mentioned, univents were found deactivated in many rooms/areas in the school at the time of assessment (Picture 3; Table 1) and some room occupants reported that the univents in their rooms were nonfunctional and had been so for a significant period of time. In addition, some univents were found obstructed by furniture and other items on top of air diffusers and/or in front of return vents along the bottom of the units (Picture 1). Other univents were found with missing/damaged covers and panels ajar (Picture 4), which can allow air to bypass the filter and allow dust and dirt to be entrained inside. In one case the univent cover was held on by tape (Picture 4). The univents that were opened and examined were found to have accumulated dust and debris inside (Picture 5). Univent cabinets, intakes and diffusers should be vacuumed out each time the filter is changed to remove dust and debris. In order for univents to provide fresh air as designed, they must remain "on" and operating while rooms are occupied. Furthermore, units must remain free of obstructions.

Exhaust ventilation in classrooms is provided by either unit exhaust ventilators or wall-mounted exhaust vents ducted to rooftop motors. While similar to appearance to a univent, unit exhaust ventilators lack a fresh air supply on the top of the unit and are designed to draw air directly to the outside of a building (Picture 6). In addition, a number of wall-mounted exhaust vents were blocked at the time of assessment (Picture 7). As with supply ventilation, exhaust ventilation must be free of blockages and allowed to operate while the building is occupied. Also note that the room configuration with both univents and unit exhausts on the outside wall can lead to poor mixing/circulation of air.

Note that the univents and unit exhausts are original equipment, and therefore greater than 35 years old. Function of equipment of this age is difficult to maintain, since compatible replacement parts are often unavailable. According to the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), the service life[1] for a unit heater, hot water or steam is 20 years, assuming routine maintenance of the equipment (ASHRAE, 1991). Despite repeated attempts to maintain these units, the operational lifespan of the equipment has been exceeded. Maintaining the balance of fresh air to exhaust air will become more difficult as the equipment ages and as replacement parts become increasingly difficult to obtain.

Mechanical ventilation for interior classrooms and common areas (e.g., auditorium, gymnasium) is provided by rooftop air-handling units (AHUs). Fresh air is distributed via ceiling or wall-mounted air diffusers or supply grills and ducted back to AHUs via ceiling or wall-mounted return vents. In many interior classrooms, the ventilation system was not operating, in particular the lower level computer rooms (1228 & 1230). In addition, the location of some of the exhaust vents relative to the supply vents (e.g., those located in close proximity on the same wall) are not optimal for airflow in the room, as fresh air can be captured by the exhaust vent before mixing with the room air. In the library, some supply vents were blocked with

[1] The service life is the median time during which a particular system or component of …[an HVAC]… system remains in its original service application and then is replaced. Replacement may occur for any reason, including, but not limited to, failure, general obsolescence, reduced reliability, excessive maintenance cost, and changed system requirements due to such influences as building characteristics or energy prices (ASHRAE, 1991).

cardboard (Picture 8). In many rooms exhaust vents are located near hallway doors, which are generally left open. However, with the hallway doors open the exhaust vent will tend to draw air from the hallway *into* the classroom, instead of drawing stale air *from* the classroom. Therefore it is recommended that classroom doors remain shut while exhaust vents are operating to function as designed.

Some areas did not have any mechanical ventilation components (e.g., supply, exhaust), nor did these areas contain openable windows (1305A, 1411 field house classroom, 3002, Athletic Director's office, Home Ec. Office). Therefore no means to introduce outside air or air exchange are provided in these areas.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

Minimum design ventilation rates are mandated by the Massachusetts State Building Code (MSBC). Until 2011, the minimum ventilation rate in Massachusetts was higher for both occupied office spaces and general classrooms, with similar requirements for other occupied spaces (BOCA, 1993). The current version of the MSBC, promulgated in 2011 by the State Board of Building Regulations and Standards (SBBRS), adopted the 2009 International Mechanical Code (IMC) to set minimum ventilation rates. **Please note that the MSBC is a minimum standard that is not health-based**. At lower rates of cubic feet per minute (cfm) per occupant of fresh air, carbon dioxide levels would be expected to rise significantly. A ventilation rate of 20 cfm per occupant of fresh air provides optimal air exchange resulting in carbon dioxide levels at or below 800 ppm in the indoor environment in each area measured. MDPH recommends that carbon dioxide levels be maintained at 800 ppm or below. This is because most environmental and occupational health scientists involved with research on IAQ and health effects have documented significant increases in indoor air quality complaints and/or health effects when carbon dioxide levels rise above the MDPH guidelines of 800 ppm for schools, office buildings and other occupied spaces (Sundell et al., 2011). 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. 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 happens, 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 MDPH 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. For more information concerning carbon dioxide, consult Appendix A.

Restrooms, including the locker/shower rooms, are equipped with local exhaust vents, but many of them were not operating at the time of assessment. The culinary arts classroom is equipped with large shutter-equipped exhaust vents over the industrial-sized stoves/ovens (Picture 9). They were not on at the time of the visit because the ovens were not in use, but they appeared to be in good condition. The kiln room, dark room and library copy area are not equipped with dedicated exhaust ventilation, and the regular exhaust ventilation in these areas was weak, blocked or not functioning at the time of the visit (Table 1). Areas/equipment with a high potential to generate heat, moisture, particulates or odors should be equipped with local exhaust ventilation to remove these from the air directly to outdoors rather than allowing for recirculation through the building.

Temperatures ranged from 66°F to 77°F, with the majority of readings within the MDPH recommended range, while a few locations, including the field house area, were below it (Table 1). The MDPH recommends that indoor air temperatures be maintained in a range of 70°F to 78°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. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., supply/exhaust ventilation deactivated/obstructed).

Relative humidity measurements in the building ranged from 30 to 52 percent at the time of assessment, which were within or somewhat below the MDPH recommended comfort range in areas surveyed (Table 1). The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

There were reports of water leaks from the roof, including hallways and some classrooms. There were also reported leaks from plumbing in some classrooms, including from univent pipes. Water-damaged ceiling tiles, missing tiles and buckets used to collect water from the ceiling were observed (Pictures 10 through 12). Water-damaged ceiling tiles can be a source of microbial growth and should be replaced once the water leaks have been repaired. Missing ceiling tiles can allow pollutants from above the ceiling to enter into occupied spaces or travel from one area to another. Other water-damaged materials, including metal lockers (Picture 13), and peeling floor tiles were also seen during the assessment. Non-porous materials such as metal are not likely to support microbial growth, but extended/repeated water exposure can cause deterioration of materials and loss of function.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Sinks were observed in many areas. There was evidence of past water leaks under some of the sinks (Picture 14), and porous items such as paper and cardboard were stored under sinks.

When porous items, including the wood of the cabinets, are moistened by plumbing leaks they can be subject to microbial growth.

Plants were observed in some areas, including on univents (Table 1). Plants should be properly maintained and equipped with drip pans. Plants should also be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold. Plants should not be placed on porous materials, since water damage to porous materials may lead to microbial growth.

Missing/damaged caulking was observed around windows (Picture 15 and 16), which can result in air/moisture infiltration and damage to interior building materials (e.g., walls, ceiling tiles, flooring). Depending on its age, window (and joint) sealant may be composed of regulated materials [e.g., asbestos, polychlorinated biphenyls (PCBs)]. If so, materials should be addressed in accordance with US Environmental Protection Agency (US EPA) regulations. For additional information regarding PCBs, please consult MDPH guidance (Appendix B).

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the indoor environment, BEH/IAQ staff obtained measurements for carbon monoxide and PM2.5.

Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 2011). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect (ND) at the time of the assessment (Table 1). No measureable levels of carbon monoxide were detected inside the building during the assessment (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations the day of the assessment were measured at 15 $\mu g/m^3$. PM2.5 levels measured inside the building ranged from 1 to 13 $\mu g/m^3$ (Table 1). Both indoor and outdoor PM 2.5 levels were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of activities that occur indoors and/or mechanical devices can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of stoves and/or microwave ovens in kitchen areas; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Volatile Organic Compounds

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to identify materials that can potentially increase indoor VOC concentrations, BEH/IAQ staff examined rooms for products containing these respiratory irritants.

Art materials such as paint were found in several areas of the school, including the TV studio area (Picture 17). Art materials can emit a variety of TVOCs and should be used in areas with sufficient supply and exhaust ventilation.

Cleaning products were found in a number of rooms throughout the building (Table 1). Cleaning products contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. These products should be properly labeled and stored in an area inaccessible to children. In addition, a Material Safety Data Sheet (MSDS) should be available at a central location for each product in the event of an emergency. Consideration should be given to providing teaching staff with school issued cleaning products and supplies to prevent any potential for adverse chemical interactions between residues left from cleaners used by the facilities staff and those left by cleaners brought in by others.

In an effort to reduce noise, tennis balls had been sliced open and placed on the base of desk/chair legs in some classrooms (Picture 18). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause VOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997).

There are several copy rooms in the building containing photocopiers and lamination machines. Photocopiers and lamination machines can be sources of pollutants such as VOCs, ozone, heat and odors, particularly if the equipment is older and in frequent use. Both VOCs and ozone are respiratory irritants (Schmidt Etkin, 1992). Photocopiers and laminators should be kept in well ventilated rooms, and should be located near windows or exhaust vents.

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

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. Two pottery kilns were observed in a storeroom adjacent to the art area (Picture 19). Pottery kilns can be a significant source of water vapor, particulate and other related pollutants when operating. In addition, a pottery kiln is a source of waste heat that can present a safety/fire hazard. The kilns appeared to be electrically operated, and there was exhaust piping from the backs of each of them leading out of the room. The kilns were not outfitted with a hood to draw heat and pollutants from the outside of the kilns. Kilns should be vented directly outdoors and kept away from students. Bottles of pottery glazing materials were examined and they were labeled as “lead free”, which is appropriate and recommended to protect the safety and health of staff and students.

In some classrooms and offices, items were observed on windowsills, tabletops, counters, bookcases and desks (Table 1). The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

BEH/IAQ staff observed chalk/dry erase board trays containing a build-up of chalk dust (Picture 20) and whiteboard marker debris. These materials can be aerosolized by air movement from doors opening and closing, and/or foot traffic and may present a respiratory irritant.

Dust was also observed accumulated on the blades of personal fans, univent diffusers, supply vents and exhaust vents/motors (Pictures 21 through 23). Univents, vents and fans should be cleaned periodically in order to prevent them from serving as a source of aerosolized particulates.

There was a report of an odor in the nurse’s office, potentially originating from the univent. The nurse reported that the odor smelled “sour” and that reportedly persisted on clothes after the workday. The univent was opened and examined during the BEH/IAQ visit. No obvious source for the odor was identified. An oily stain was noted on the univent filter (Picture 24), which may indicate a fluid leak inside the univent, or may indicate that a small amount of lubricating oil was spilled when the unit was last serviced. It was recommended that the univent filter be changed to see if the stain reoccurs, so that any fluid leaks can be identified and repaired. In addition, the material lining the univent cover, intended to reduce noise from the unit, was noted to be soiled (Picture 25). This material cannot be cleaned, but it can be removed without changing the function of the univent which may reduce odors from the unit.

Conclusions/Recommendations

The conditions noted at WMHS raise a number of IAQ issues. The general building conditions, maintenance, operational practices, and the age/condition of ventilation equipment, considered individually, present conditions that could have an adverse impact on indoor air quality. When combined, these conditions can serve to further degrade air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons, a two-phase approach is required for remediation. The first consists of **short-term** measures to improve air quality and the second consists of **long-term** measures that will require planning and resources to adequately address overall IAQ conditions.

Short-Term Recommendations

1. Operate all ventilation systems throughout the building including univents, unit exhausts and interior classroom HVAC systems continuously during periods of occupancy to maximize air exchange and reduce excess heat, particularly in interior computer rooms (e.g., 1228 & 1230).
2. Consult with an HVAC engineering firm regarding the feasibility of repair vs. replacement of ventilation system components given their age. In the interim, work with

3. Work with an HVAC engineer to examine methods of providing mechanical ventilation to areas without the means to introduce fresh air via windows or mechanically (e.g., 305A, 1411 field house classroom, 3002, Athletic Director's office, Home Ec. Office).
4. Have HVAC firm evaluate the interior condition of ductwork and whether cleaning is recommended/necessary.
5. Remove all blockages/items from the surface of univent air diffusers and return vents (along front/bottom) to ensure adequate airflow. Remove all blockages from exhaust vents.
6. Close classroom doors to maximize exhaust capabilities and air exchange as designed.
7. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
8. Use openable windows to supplement fresh air in the classrooms during occupancy. If thermal comfort is a concern, consider opening windows between classes and during unoccupied periods. Care should be taken to ensure windows are closed at the day's end.
9. 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 dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

10. Ensure roof flashing/junctions and plumbing leaks are repaired and replace any remaining water-damaged ceiling tiles and wall materials. Examine the area above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial, as needed.

11. Have areas of cracks and missing mortar on the outside of the building repointed to prevent water infiltration.

12. Inspect all sinks for leaks and repair as needed. Refrain from storing porous items or large quantities of items under sinks.

13. Ensure indoor plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial, as needed. Move plants away from the air stream of mechanical ventilation equipment.

14. Continue to carry out annual clean-outs, inventory and inspection of science chemical storage area. Consider also performing similar measures for art and cleaning chemicals in the school.

15. Store cleaning products properly and out of reach of students. All cleaning products used at the facility should be approved by the school department with MSDSs available at a central location.

16. Ensure that the exhaust ventilation is operating every time the kiln is in use and for a period of time afterward to remove heat, particulates and other pollutants. Consider installing a hood-style exhaust vent for the kiln room.

17. Work with HVAC vendor/facilities department to install exhaust ventilation for copy rooms to remove airborne pollutants and excess heat.

18. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

19. Clean chalk and dry-erase marker trays of accumulated dust and debris regularly using a HEPA vacuum with brush attachment or damp cloth.

20. Clean air diffusers, exhaust/return vents/motors, surrounding ceiling tiles and personal fans periodically of accumulated dust.

21. Consider replacing tennis balls with latex-free tennis balls or glides.

22. Change the filter on the univent in the nurse's office and then inspect it for signs of oil leakage; repair if needed. Remove sound baffling from the cover of the univent in this room. Also inspect the exterior vent of the unit to see if odorous materials are being entrained into the unit. If these measures do not abate the odor, consider consulting an HVAC contractor for additional inspection and repair of this unit.

23. Consider adopting the US EPA (2000) document, "Tools for Schools", as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: http://www.epa.gov/iaq/schools/index.html

24. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://mass.gov/dph/iaq

Long-Term Recommendations

1. Based on the age, physical deterioration and availability of parts, the BEH recommends that an HVAC engineering firm evaluate options for providing adequate ventilation

building-wide. Such an evaluation is necessary to determine the operability and feasibility of repairing/replacing the equipment.

2. Consider a long-term plan to replace windows (where needed) to prevent air/moisture infiltration.

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Picture 1

Unit ventilator

Picture 2

Univent air intakes (examples at arrows)

Picture 3

Univent controls, showing unit in "off" position

Picture 4

Univent cover ajar/taped shut

Picture 5

Dusty interior of univent cabinet

Picture 6

Unit exhaust ventilator

Picture 7

Blocked exhaust vent

Picture 8

Blocked supply vents

Picture 9

Culinary arts room, note large exhaust hoods above cooking equipment (arrows)

Picture 10

Water-damaged and missing ceiling tiles in hallway, note water-collection bucket

Picture 11

Signs of water leakage and water-damaged ceiling tile

Picture 12

Water-damaged ceiling tiles

Picture 13

Water damage to metal lockers in girls' gym area

Picture 14

Evidence of water leak under sink

Picture 15

Missing/damaged window caulking

Picture 16

Missing/damaged window caulking

Picture 17

Silk-screening materials in television studio room

Picture 18

Tennis balls used as glides

Picture 19

Electric pottery kilns, note exhaust pipes from rear of unit, no hood exhaust

Picture 20

Chalk tray with build-up of chalk dust

Picture 21

Dusty supply vents

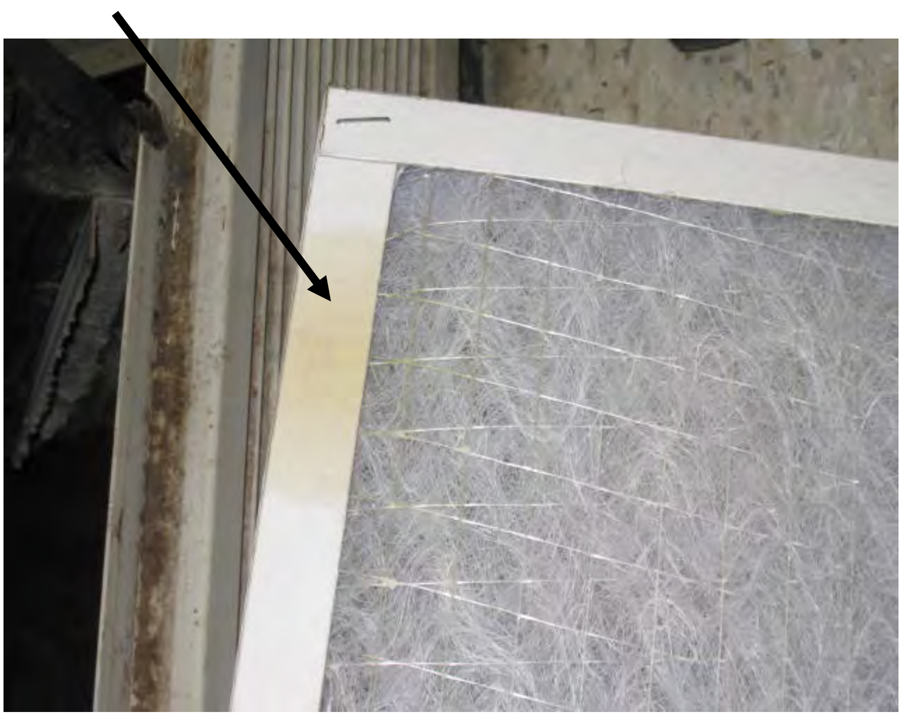
Picture 22

Dusty personal fan

Picture 23

Accumulated dust and debris inside exhaust motor

Picture 24



Oily stain (arrow) on univent filter in the nurse's room

Picture 25

Dusty/dirty sound-baffling material on univent cover in nurse's room

Location: Wakefield Memorial High School **Indoor Air Results**

Address 60 Farm Street, Wakefield, MA **Date: 11/1/2012**

Table 1

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background	395	ND	54	40	15					Sunny, light breeze, parking lot with some trucks
1 Conference	480	ND	75	32	4	0	N	Y off	Y	WD CT
5	449	ND	74	34	4	0	Y	Y off		DO, items on UV
8	481	ND	74	34	6	0	N	Y	Y off	DO
11 Copy	461	ND	74	33	5	0	N	N	N	PC, DO, MT, no exhaust
1211	1539	ND	72	48	12	23	Y	Y off	Y on	Chalk dust
1213	1119	ND	73	44	6	2	Y	Y on	Y on	WD CT, leaks reported,
1215	1032	ND	73	40	7	19	Y	Y	Y	Windows open
1217	1373	ND	71	48	9	1	N	Y	Y	Exhaust off
1223	1510	ND	74	45	9	2	N	Y dirty	Y off	DEM

ppm = parts per million
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AC = air conditioner
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CP = cleaning products
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing ceiling tile
ND = non detect
PC = photocopier
PF = personal fan
TB = tennis balls
WD = water-damaged
UV = unit ventilator (univent)

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

Location: Wakefield Memorial High School | **Indoor Air Results**

Address: 60 Farm Street, Wakefield, MA | **Date: 11/1/2012**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
1225	2204	ND	73	50	12	20 just left	N	Y dusty	Y off	Reported poor IAQ from occupants, chalk dust, TBs, on most desks, DEM DO
1227	2235	ND	73	52	10	22	Y	Y on (weak)	Y off	Chalk dust
1228 Computer room	777	ND	76	38	6	0	N	Y	Y	Supply and exhaust off, 26 computers, heat issues
1229	1900	ND	72	46	8	14	Y	Y off	Y off	UV cover broken, CP, DO
1230 Computer room	1019	ND	77	40	7	13	N	Y	Y	Supply and exhaust off, MT, 7 WD CTs, heat issues, network equipment=extra heat
1231	3050	ND	73	52	12	10	Y	Y off	Y off	Chalk dust
1232 Computer room		ND	74	44	13	Just left	N	Y dusty	Y off	30 computers, chalk dust
1234 inner office	974	ND	72	45	9	1	N	Y dusty	N	Small fridge
1234 work room	1016	ND	72	44	10	0	N	Y off	Y off	

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Location: Wakefield Memorial High School **Indoor Air Results**

Address: 60 Farm Street, Wakefield, MA **Date: 11/1/2012**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (μg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
1236 Business	890	ND	73	42	7	0	N	Y	Y	Supply and exhaust off
1237	899	ND	71	43	7	0	Y	UV off		Items on UV, DEM, chalk dust, DO
1239	824	ND	72	38	7	1, others left recently	Y	UV		Items on UV
1240 School psych	1082	ND	72	43	9	0	N	Y dirty	Y	Food odors
1241	1040	ND	75	42	8	14	Y	2 UV, 1 on	Y	Pottery wheels, accumulated items, lead-free glazes
1243	771	ND	73	38	6	21	Y	2 UV, one cover broken	Y off	Papers and accumulated items, sinks
1245	782	ND	76	37	7	2	N			Accumulated items, microwave, fridge
1247	857	ND	74	39	7	22	Y 1 open	2 UV blocked		Plant, sink drips, CP
1247 Kiln area										Kilns not on, hard piped exhaust from rear, no hood exhaust, PF

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Location: Wakefield Memorial High School **Indoor Air Results**

Address: 60 Farm Street, Wakefield, MA **Date: 11/1/2012**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
1249		ND	74	46	8	15	Y	Y off		Solar gain, chalk dust
1253	574	ND	71	34	7	0	Y open	Y off	Y dusty	Small room, trees outside window, sink is dirty
1301	610	ND	72	34	6	11	Y open	Y off	Y	Trees outside window/UV, items on UV
1303 Culinary art	692	ND	72	38	7	3	Y	Y	dedicated exhaust for cooking equip.	DO, many appliances, ovens, large fridge, food, DEM
1304 by windows	571	ND	73	37	8	0	Y	Y		MT
1304 office	603	ND	73	37	9	0	N	Y	Y	Small office, clutter
1304 TV	1141	ND	73	45	8	13	Y	Y	Y off	MT, food and items in adjacent break room, sink
1305 (Cafe)	540	ND	71	36	6	5	Y	Y off	Y	Artificial plants, WD CT
1305 A	543	ND	71	43	7	0	N	N	N	half office size, MT, fan in door transom

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	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

Location: Wakefield Memorial High School **Indoor Air Results**

Address: 60 Farm Street, Wakefield, MA **Table 1 (continued)** **Date: 11/1/2012**

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (μg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
1307 Home ec.	582	ND	72	38	6	7	Y	Y on		WD CT, kitchen items, WD under sink, dryer vent hard piped ok
1312	718	ND	74	43	6	6	Y	Y blocked	Y blocked	Dishwashers, computers, sinks, oven, backsplash on sink ok, appliances
1314 Living center	765	ND	75	38	6	0	Y	Y off		
1316	700	ND	72	42	7	5	Y	Y off		DEM, CP under sink, computers, toaster
1401	990	ND	72	44	6	5	Y	Y	Y	
1401 work room	1061	ND	72	45	8	0	N	Y Passive door vent	Y	Supply and exhaust off, 7 WD CTs-staining down wall, MTs
1404 Girls locker	419	ND	73	31	5	0	N	Y	Y	AHU in locked off area, lockers and showers
1411 Field house	459	ND	67	46	5	0	N	N	N	Recommend passive vents to FH or mechanical vent
1413 Field house	423	ND	66	42	2	0	N	Y	N	2 ceiling-mounted UVs-dusty

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Particle matter 2.5 < 35 ug/m^3

Location: Wakefield Memorial High School **Indoor Air Results**

Address: 60 Farm Street, Wakefield, MA **Date: 11/1/2012**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
1418	656	ND	72	38	6	0	N	Y	Y	Supply and exhaust off, WD CT
1440 Girls gym instructor	400	ND	74	30	4	1	N	Y		Reports of little flies (not seen at time of visit), DO
2005	456	ND	74	42	4	1	Y	Y dusty	N	Plants
2007 office	589	ND	73	38	4	1	Y	Y off		DEM, carpet
2010 Laura's office	737	ND	73	42	4	1	Y	Y	N	AC filter-dusty, broken window, MTs
2114 Math department office	609	ND	71	38	3	0	N	Y	N	PC, 4 WD CTs, DO
2114 Math office	597	ND	72	38	3	2	N	N	Y	3 WD CTs, active leaks reported, PC
2200	888	ND	72	45	9	10	N	Y dusty		Carpet soiled
2204	764	ND	72	39	2	19	N	Y	Y	Chalk dust, MT/WD, auxiliary exhaust vents

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Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
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Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m³)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
2206/2228	675	ND	74	35	4	16	N	Y dusty	Y on	Sink drips, incubator, DEM, lab sinks
2210 Science lecture	525	ND	74	34	4	0	N	Y dusty		PF
2210 Science lecture hall	734	ND	73	38	4	0	N	Y	Y	
2213 Language lab	624	ND	73	37	9	0	N	Y	Y dusty	Food odors, fridge, microwave, sink, toaster, PC
2217	627	ND	73	36	3	0	N	Y dusty	Y on	Interior room, WD CT, exhaust by door
2218 Science department office	509	ND	72	36	3	0	N	Y	N	Dust around supply vent
2219	531	ND	73	37	3	19	N	Y dusty	Y blocked	CD, bowed CTs, exhaust blocked
2221	850	ND	74	37	2	22	Y	Y	Y	Window open, complaints of debris from vent over desk
2223	1108	ND	73	41	5	13	Y	Y off	Y	WD CT, lab sinks, DO, CD

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Carbon Dioxide:	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems	Temperature: Relative Humidity: Particle matter 2.5	70 - 78 °F 40 - 60% < 35 ug/m³

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
2226	472	ND	72	36	7	1	N	Y	Y wall near door	WD-CTs, MT, reported complaint of mold in spring
2226 storage	571	ND	72	34	2	0	N	Y	Y	MT, accumulated items
2227	885	ND	73	38	5	7	Y	Y off	Y by door	Lab sinks, hood inspected 7/12 (ok), WD CT
2231	1099	ND	73	43	4	22	Y	Y	Y	Supply and exhaust off, cobwebs-windowsill
2233/2235	1168	ND	72	44	5	23	Y	Y	Y	Supply and exhaust off, WD CTs, MTs
2234	1212	ND	73	46	5	18	Y	Y	Y	Exhaust off-near open door, 7 WD CTs, UV cover taped on
2239 Biology	1123	ND	71	49	9	1	Y	Y	Y next to door	Items under sink, DO, WD CT, plants on UV, chalk dust, DEM
2241	677	ND	70	39	8	Gone 5 minutes	Y	Y off		DEM, DO, items under sink, physics items, dusty
2241 Physics	670	ND	71	40	7	0	Y	Y	Y	Supply off, exhaust near open door

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Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
2247	640	ND	71	37	7	2	Y	Y off	Y off	Sink, microwave, soda machine, PC, items under sink and water damage under sink, DO
2300	1677	ND	73	49	8	21	Y	Y	Y	Supply and exhaust off, DO, TB, exhaust vent damaged
2302	1650	ND	74	48	12	0	N	Y dusty	Y off	Re-activated UV, lots of debris, WD cardboard
2304	1897	ND	75	47	8	0	Y	Y	Y	Occupants gone 20-25 mins, UV-filter door screwed shut
2305	1680	ND	75	44	10	9	Y	Y	Y off	Items on UV, AP, DEM, CP
2306	2179	ND	74	50	10	18	Y	Y	Y	UV-missing top panel, supply and exhaust off, MTs-leaks reported during heavy wind/rain, stained pipe, DO
2307	2479	ND	76	48	11	22	Y	Y off	Y off	Items on UV, PF dusty, DEM, pencil sharpeners on UV, chalk dust
2308	1953	ND	73	48	10	0	Y	Y	Y	Supply and exhaust off, UV blocked by file cabinets

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Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m³)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
2309	1691	ND	75	45	10	26	Y	Y off	Y off, dusty	Solar gain from windows, PF, chalk dust, DEM
2310	2538	ND	74	49	8	9	Y	Y off	Y off	DEM, PF, 1 AT, possible oil/fluid leak in UV
2310 Earth Science	860	ND	74	39	7	15	Y 3 open	Y on	Y on	Chalk dust, DEM, DO, CP under sink
2311	1312	ND	75	40	9	15	Y	Y off, damaged /ajar cover	Y off	Solar gain – shades down, chalk dust, DEM, DO, TBs (one desk)
2313	844	ND	73	35	8	gone 40 minutes	Y 3 open	Y off	Y off	DEM, chalk dust, PF
2nd floor Hallway										Buckets on top of lockers- leaks?
3000	613	ND	72	37	5	2	Y	N	N	MTs, door removed between office and room
3002 Dept. coord.	920	ND	72	37	5	0	N	N	N	No ventilation or windows
3002 Dept. coord. office	869	ND	75	42	5	0	Y	Y	N	UV-off, recommend passive vent in door or mech. exhaust

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Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (μg/m³)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
3003	1429	ND	73	51	13	14	Y	Y	Y	Occupant reported that univent damaged last year and has not been repaired. Chalk dust, DEM, DO, PF, sanitizer, items on UV
3005	1163	ND	75	42	11	25 just left	Y 2 open	Y off	Y	Chalk dust, DEM, WD CT, food containers, walls discolored
3006	831	ND	77	36	5	2	Y	Y	N	PC, UV return blocked/boxes, fan dusty
3007	1212	ND	73	42	12	gone 5 minutes	Y open	Y off	Y	Items on UV, dioramas, chalk dust
3008	1044	ND	75	40	5	1	Y	Y	Y	Window open, supply and exhaust not operating
3009	1440	ND	73	46	12	Gone 5 minutes	Y	Y off	Y	DO, chalk dust, DEM
3011	1309	ND	74	45	11	Gone 10 minutes	Y	Y off	Y	Reported water damage or mold problems, recently fixed CT (formerly bucket for capturing water from roof leak), PF

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Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
3012	1800	ND	75	48	5	26	Y	Y	Y	Supply not operating
3013	1374	ND	72	50	11	0	Y	Y off	Y	DEM
Athletic Director	606	ND	68	45	4	1	N	N	N	No windows or mechanical ventilation
B&G office	654	ND	72	42	7	2	N			
Book storage room										MT
Boys locker room	566	ND	76	35	2	0	N	Y	Y	HVAC off/weak, shower exhaust vents off, odors
Business office	960	ND	73	44	7	1	N	Y	N	2 WD CTs, no airflow
Chemical storage										Proper flammables cabinet with labels, corrosives cabinet, shelves neat/organized (see photos)
Conference A	503	ND	73	33	5	0	Y	Y	N	

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Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Dark Room (2nd floor, used for storage)	593	ND	70	38	5	0	N	Y	Y on	Reportedly has not been used as darkroom for 12+ years (active darkroom is on first floor)
Dark Room, 1st floor (Active)	877	ND	73	40	6	0	N	not located	Y	Chemical odors, HEPA AP (on), uses small exhaust grills, no hood or dedicated exhaust. Exhaust draw weak, hole in wall
Dennis O'Leary	449	ND	73	32	4	0	Y	Y dusty		
Equip room	510	ND	73	42	1	0	N	Y	N	No exhaust, dirty supply vents
Field House (FH)	472	ND	66	45	6	14	N	Y	Y	
Hallway 2nd Floor										WD/MTs
Home Ec. Office	532	ND	73	32	7	1	N	N	N	
Home ec. prep/storage room	455	ND	72	31	6	0	Y open	Y blocked	Y	Accumulated items

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								Supply	Exhaust	
Large cafeteria	1327	ND	75	42	9	~300	Y and exterior door	Y	Y	Light visible under exterior door
Librarian office	649	ND	72	40	8	0	N	Y blocked		DO, accumulated items, plants
Library copy lounge	644	ND	72	39	9	2	N	Y some blocked		CP, no dedicated exhaust for copiers or laminator, microwave, sink
Library lower level	840	ND	72	43	9	14	N	Y	Y	WD CT, students scattered in large space, carpet, computers, PC
Library, upper area	785	ND	72	43	10	0	N	Y dirty	Y	MT to computer/electrical equipment, carpet, plush furniture
Main Office	552	ND	74	33	4	2	Y	Y		PF
Mrs. O'Keefe	477	ND	74	33	5	1	Y	Y UV		Accumulated items on UV, AP
Nurse	503	ND	74	32	4	3	Y	Y UV		Odor reported from UV "sour smell", UV opened, oil stain on filter

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Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems	Temperature: Relative Humidity: Particle matter 2.5	70 - 78 °F 40 - 60% < 35 ug/m^3

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Physics prep										Sink not used, items under sink
Principal's office	638	ND	71	41	9	5	Y	Y	Y	
School store	897	ND	73	39	12	5	Y	Y	Y	Items on univent
Science workroom	502	ND	74	35	3	0	N	Y dusty		Sink, fridge, other cooking equipment
Second floor girls restroom									Y	No exhaust on, cleaner/deodorizer odor, MT
Second floor Storeroom										Several PF, TV, books stored in piles, MT
Small cafeteria	1300	ND	75	41	5	~200	Y	Y	Y	AHU-ceiling, WD CTs
Studio room	470	ND	73	36	8	0	N	Y	Y	Equipment, silk screen items, DEM
Team A room	549	ND	73	44	2	0	N	Y	N	Strong odors, weak ventilation, no exhaust

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
AC = air conditioner
AP = air purifier
CP = cleaning products
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing ceiling tile
ND = non detect
PC = photocopier
PF = personal fan
TB = tennis balls
WD = water-damaged
UV = unit ventilator (univent)

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

Location: Wakefield Memorial High School **Indoor Air Results**

Address: 60 Farm Street, Wakefield, MA **Date: 11/1/2012**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (μg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Team room	582	ND	70	47	2	0	N	Y	Y	HVAC reportedly running on ½ capacity
Weight room	460	ND	70	41	3	0	N	Y	Y	

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μg/m^3 = micrograms per cubic meter
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Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Buildings

Prepared by

Bureau of Environmental Health
Massachusetts Department of Public Health

December 2009

INTRODUCTION

The purpose of this information booklet is to provide assistance to school and public building officials and the general public in assessing potential health concerns associated with polychlorinated biphenyl (PCB) compounds in building materials used in Massachusetts and elsewhere. Recently, the U.S. Environmental Protection Agency (EPA) provided broad guidance relative to the presence of PCBs in building materials, notably PCBs in caulking materials. The most common building materials that may contain PCBs in facilities constructed or significantly renovated during the 1950s through the 1970s are fluorescent light ballasts, caulking, and mastic used in tile/carpet as well as other adhesives and paints.

This information booklet, developed by the Massachusetts Department of Public Health's Bureau of Environmental Health (MDPH/BEH), is designed to supplement guidance offered by EPA relative to potential health impacts and environmental testing. It also addresses managing building materials, such as light ballasts and caulking, containing PCBs that are likely to be present in many schools and public buildings across the Commonwealth. This is because the Northeastern part of the country, and notably Massachusetts, has a higher proportion of schools and public buildings built during the 1950s through 1970s than many other parts of the U.S. according to a 2002 U.S. General Accounting Office report. The Massachusetts School Building Authority noted in a 2006 report that 53 percent of over 1,800 Massachusetts school buildings surveyed were built during the 1950s through 1970s. This information booklet contains important questions and answers relative to PCBs in the indoor environment and is based on the available scientific literature and MDPH/BEH's experience evaluating the indoor environment of schools and public buildings for a range of variables, including for PCBs as well as environmental data reviewed from a variety of sources.

1. What are PCBs?

Polychlorinated biphenyl (PCB) compounds are stable organic chemicals used in products from the 1930s through the late 1970s. Their popularity and wide-spread use were related to several factors, including desirable features such as non-flammability and electrical insulating properties. Although the original use of PCBs was exclusive to closed system electrical applications for transformers and capacitors (e.g., fluorescent light ballasts), their use in other applications, such as using PCB oils to control road dust or caulking in buildings, began in the 1950s.

2. When were PCBs banned from production?

Pursuant to the Toxic Substance Control Act (TSCA) of 1976 (effective in 1979), manufacturing, processing, and distribution of PCBs was banned. While the ban prevented production of PCB-containing products, it did not prohibit the use of products already manufactured that contained PCBs, such as building materials or electrical transformers.

3. Are PCBs still found in building materials today?

Yes. Products made with PCBs prior to the ban may still be present today in older buildings. In buildings constructed during the 1950s through 1970s, PCBs may be present in caulking, floor mastic, and in fluorescent light ballasts. Available data reviewed by MDPH suggests that caulking manufactured in the 1950s through 1970s will likely contain some levels of PCBs. Without testing it is unclear whether caulking in a given building may exceed EPA's definition of PCB bulk product waste of 50 parts per million (ppm) or greater. If it does, removal and disposal of the caulk is required in accordance with EPA's TSCA regulations (40 CFR § 761).

4. Are health concerns associated with PCB exposure opportunities?

Although the epidemiological evidence is sometimes conflicting, most health agencies have concluded that PCBs may reasonably be anticipated to be a carcinogen, i.e., to cause cancer.

PCBs can have a number of non-cancer effects, including those on the immune, reproductive, neurological and endocrine systems. Exposure to high levels of PCB can have effects on the liver, which may result in damage to the liver. Acne and rashes are symptoms typical in those that are exposed to high PCB levels for a short period of time (e.g., in industry / occupational settings).

5. If PCBs are present in caulking material, does that mean exposure and health impacts are likely?

No. MDPH/BEH's review of available data suggests that if caulking is intact, no appreciable exposures to PCBs are likely and hence health effects would not be expected. MDPH has conducted indoor tests and reviewed available data generated through the efforts of many others in forming this opinion.

6. How can I tell if caulking or light ballasts in my building may contain PCBs?

If the building was built sometime during the 1950s through 1970s, then it is likely that the caulking in the building and/or light ballasts may contain some level of PCBs. Light ballasts manufactured after 1980 have the words "No PCBs" printed on them. If the light ballast does not have this wording or was manufactured before 1980, it should be assumed that it contains PCBs.

7. What are light ballasts?

A light ballast is a piece of equipment that controls the starting and operating voltages of fluorescent lights. A small capacitor within older ballasts contains about one ounce of PCB oil. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air.

8. Does the presence of properly functioning fluorescent light ballasts in a building present an environmental exposure concern?

No appreciable exposure to PCBs is expected if fluorescent light ballasts that contain PCBs are intact and not leaking or damaged (i.e., no visible staining of the light lenses), and do not have burned-out bulbs in them.

9. Should I be concerned about health effects associated with exposure to PCBs as a result of PCB-containing light ballasts?

While MDPH has found higher PCB levels in indoor air where light bulbs have burned-out, the levels are still relatively low and don't present imminent health threats. A risk assessment conducted recently at one school did not suggest unusual cancer risks when considering a worst case exposure period of 35 years for teachers in that school. Having said this, MDPH believes that facility operators and building occupants should take prompt action to replace bulbs and/or ballasts as indicated to reduce/eliminate any opportunities for exposure to PCBs associated with PCB-containing light ballasts.

10. When should PCB-containing light ballasts be replaced?

If ballasts appear to be in disrepair, they should be replaced immediately and disposed of in accordance with environmental regulatory guidelines and requirements. However, if light bulbs burn out, the best remedy is to change them as soon as possible. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air. Thus, burned-out bulbs should be replaced promptly to reduce overheating and stress on the ballast. As mentioned, ballasts that are leaking or in any state of disrepair should be replaced as soon as possible.

It should be noted that although older light ballasts may still be in use today, the manufacturers' intended lifespan of these ballasts was 12 years. Thus, to the extent feasible or in connection with repair/renovation projects, the older light ballasts should be replaced consistent with the intended lifespan specified by the manufacturers.

11. Does MDPH recommend testing of caulking in buildings built during the 1950s - 1980?

Caulking that is intact should not be disturbed. If caulking is deteriorating or damaged, conducting air and surface wipe testing in close proximity to the deteriorating caulking will help to determine if indoor air levels of PCBs are a concern as well as determining the need for more aggressive cleaning. Results should be compared with similar testing done in an area without deteriorating caulking. In this way, a determination can be made regarding the relative contribution of caulking materials to PCBs in the general indoor environment.

12. What if we determine that caulking in our building is intact and not deteriorating?

Based on a review of available data collected by MDPH and others, the MDPH does not believe that intact caulking presents appreciable exposure opportunities and hence should not be disturbed for testing. As with any building, regular operations and maintenance should include a routine evaluation of the integrity of caulking material. If its condition deteriorates then the steps noted above should be followed. Consistent with EPA advice, if buildings may have materials that contain PCBs, facility operators should ensure thorough cleaning is routinely conducted.

13. Should building facilities managers include information about PCB-containing building materials in their Operations and Maintenance (O&M) plans?

Yes. All buildings should have an O&M plan that includes regular inspection and maintenance of PCB building materials, as well as thorough cleaning of surfaces not routinely used. Other measures to prevent potential exposure to PCBs include increasing ventilation, use of HEPA filter vacuums, and wet wiping. These O&M plans should be available to interested parties.

14. Are there other sources of PCBs in the environment?

Yes. The most common exposure source of PCBs is through consumption of foods, particularly contaminated fish. Because PCBs are persistent in the environment, most residents of the U.S. have some level of PCBs in their bodies.

15. Where can I obtain more information?

For guidance on replacing and disposing of PCB building materials, visit the US EPA website: http://www.epa.gov/pcbsincaulk/. For information on health concerns related to PCBs in building materials, please contact MDPH/BEH at 617-624-5757.