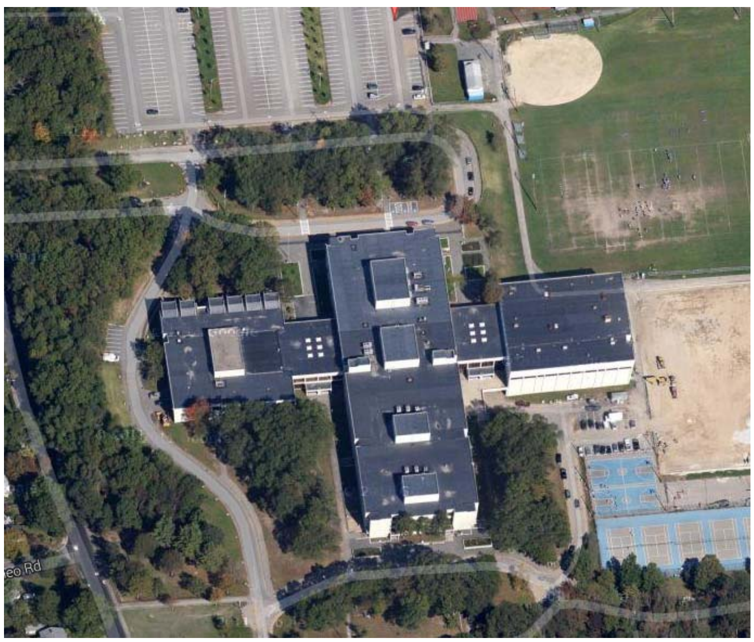
INDOOR AIR QUALITY ASSESSMENT

Braintree High School
128 Town Street
Braintree, MA



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
June 2014

Background/Introduction

In response to a referral from both the Occupational Safety and Health Administration (OSHA) and the Massachusetts Department of Labor and Standards, Division of Occupational Safety (DOS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality (IAQ) concerns at Braintree High School (BHS) located at 128 Town Street, Braintree, MA. On May 21, 2014, Cory Holmes, Environmental Analyst/Regional Inspector in BEH's IAQ Program visited the BHS to conduct an IAQ assessment. The assessment was coordinated through both the Braintree Health and School Departments and focused on interior "core" rooms on the second and third floors of the building which were areas of concern identified in the OSHA complaint.

The school is a three-story concrete/cement block building built in the early 1970s. The main floor consists of general classrooms, gymnasium, cafeteria, auditorium, and shop areas. The second floor includes the media center, offices, general classrooms, science rooms, art rooms, darkrooms and the home economics area. The third floor contains general classrooms and guidance offices. The perimeter rooms of the building have openable windows with the exception of the art rooms of the west wing. Interior "core" rooms in the center of the building do not have windows and therefore rely solely on mechanical ventilation for the introduction of fresh/outside air and air exchange.

Methods

Air tests for carbon monoxide, carbon dioxide, 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 8532. BEH/IAQ staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 1,545 students in grades 9 through 12 with a staff of approximately 250. Tests were taken during normal operations at the school. Results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in 26 of 35 areas surveyed at the time of assessment, indicating adequate air exchange in roughly three quarters of these areas. Please note however that some areas were empty or sparsely populated at the time tests were taken, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with full occupancy.

Outside air for the interior "core" classrooms and common areas (e.g., guidance/house offices) surveyed during this assessment is provided by 13 air handling units (AHUs) located on the roof, enclosed in mechanical penthouses (Pictures 1 and 2). Fresh air is drawn in through intakes, where it is filtered, heated or cooled and ducted to wall or ceiling-mounted supply diffusers (Pictures 3 and 4). Return air is drawn in through wall or ceiling-mounted return vents and ducted back to AHUs.

It was reported that the air conditioning compressor units have been replaced over the last few years, however it is important to note that all 13 of the rooftop AHUs are original to the building's construction (early 1970s), which makes them over 40 years old. Efficient function of equipment of this age is difficult to maintain, since compatible replacement parts are often unavailable, which was apparent by repairs and retro-fitted replacement parts on control panels (Pictures 5 and 6). According to the American Society of Heating, Refrigeration and Air-Conditioning Engineering (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 attempts to maintain the equipment, the optimal operational lifespan of this equipment has been exceeded.

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 that heating, ventilating and air conditioning (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 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

[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).

Mechanical Code (IMC) to set minimum ventilation rates. **<u>Please note that the MSBC is a minimum standard that is not health-based</u>**. 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.

Indoor temperature measurements the day of assessment ranged from 68 °F to 74 °F (Table 1), which were within or close to the MDPH recommended comfort range. 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. Temperature control complaints were expressed in a number of areas; it was reported to BEH/IAQ staff that in order to adjust temperatures for each AHU, maintenance staffs have to physically go up on the roof and manually adjust the units. This practice is not only inefficient but can also be a safety hazard under snow/ice conditions. As discussed previously, although the rooftop units are still functioning, their optimal lifespan has been exceeded, which may require an update of equipment and/or control systems. 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.

The relative humidity measured in the building during the assessment ranged from 44 to 53 percent, which was within the MDPH recommended comfort range in all 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

Water-damaged ceiling tiles were observed in several classroom and hallway areas (Picture 7; Table 1). These indicate current/historic roof leaks, plumbing leaks or other water infiltration. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired.

Several rooms had aquariums/terrariums, some of which contained debris/residue and appeared not to have been used or maintained for some time (Pictures 8 and 9; Table 1). Aquariums and terrariums should be properly maintained to prevent bacterial/mold/algal growth and associated nuisance odors. If not in use, these items should be properly cleaned and stowed.

Plants and cut flowers were noted in some classrooms (Picture 10; Table 1). Plants can be a source of pollen and mold, which can be respiratory irritants to some individuals. Plants should be properly maintained and equipped with drip pans and should be located away from air supplies to prevent the aerosolization of dirt, pollen and mold.

The refrigerator in room 370 was examined and found to have visible mold growth/staining of gaskets (Picture 11). The gaskets are composed of non-porous material that should be cleaned and disinfected using an appropriate antimicrobial.

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 effects. 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. On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). No measurable levels of carbon monoxide were detected inside the building (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter includes airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to PM with a diameter of 10 μm or less (PM10). In 1997, US EPA established a more protective standard for fine airborne particulate matter with a diameter of 2.5 μm or less (PM2.5). 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 PM concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 3 to 5 $\mu g/m^3$ (Table 1). PM2.5 levels measured in the building ranged from 2 to 4 $\mu g/m^3$ (Table 1), which 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 matter 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.

Science rooms and the chemical storage area were examined. In some cases science materials were being stored in unattended lab hoods, with some containers caked with residue (Pictures 12 and 13). Unknown chemical debris was noted on the flat surface inside some lab hoods as well as on chemical storage shelves (Pictures 14 and 15). These unknown materials should be properly cleaned to avoid exposure to occupants, cross-contamination of experiments or adverse reactions with other materials present. Flammable materials were also noted on open shelves instead of flammable storage cabinets (Picture 16). Some chemical containers were not properly sealed with caps, but rather with a plastic film (Picture 17). This method of sealing should be *temporary only* with proper tightly-fitted caps used for long-term storage to avoid off-gassing of materials into occupied areas and mixing with other chemicals that may be present/stored in similar fashion. In addition, regular cleanouts of chemical storage areas is recommended. Attached as Appendix B is "Guidance Concerning Proper Use and Storage of Chemicals in Schools to Protect Public Health" for additional reference.

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 IAQ were observed during the assessment. The type of filter medium for air handling equipment used by the school comes in a bulk roll and must be cut to size before it is inserted into a metal lattice "cage" (Pictures 18 through 21). This method is extremely time intensive, and the results are variable. If the filter medium is not properly fitted, gaps can allow unfiltered air into the room and/or reduce the useful life of the unit. It should be determined if disposable filters with an appropriate dust spot efficiency and similar cost can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Pleated filters with a Minimum Efficiency Reporting Value dust-spot efficiency of 9 or higher are recommended. Note that increasing filtration can reduce airflow (called pressure drop), which can subsequently reduce the efficiency of the unit due to increased resistance. Prior to any increase of filtration, each AHU/univent should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

In many classrooms, large numbers of items were on floors, windowsills, tabletops, counters, bookcases and desks, which provide a source for dusts to accumulate (Pictures 22 through 24). 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, dust and debris can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

A number of air diffusers, exhaust/return vents, personal fans and in particular; surrounding ceilings, walls, and ceiling tiles were found to have accumulated staining/dust/debris (Pictures 3, 4, 25 through 27; Table 1). The majority of ceiling tiles are of a "tactile" type which are difficult to clean and/or replace when they become soiled or water-damaged. In one classroom, the occupant installed a section of bulk filter media over the vent (Picture 28). Re-activated supply vents and fans can aerosolize dust/materials accumulated in equipment or on vents/fan blades. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles.

Accumulations of chalk dust and dry erase particulate were observed in several classrooms (Picture 29; Table 1). These materials can also be aerosolized by air movement from the ventilation system or opening/closing of doors; aerosolized materials may present an eye or respiratory irritant.

Conclusions/Recommendations

In light of MDPH observations, complaints about building conditions (e.g. dust/particulates, temperature/ventilation control/comfort) as well as referrals from both OSHA and DOS, the Massachusetts BEH/IAQ Program highly recommends the following recommendations to improve IAQ/comfort conditions in the building:

1. Operate all supply and exhaust ventilation systems throughout the building continuously during periods of occupancy to maximize air exchange.

2. Teachers/staff are encouraged to report all classroom environmental issues (e.g., temperature/comfort issues, cleaning/repair requests) to school administration using the "Indoor Air/Environmental Health Form" provided (Appendix C). In addition, a system should be developed/in-place to *track* the status of each request/form to document resolution.
3. Adjust the percentage of fresh air supplied to and/or exhausted by the HVAC system to improve air exchange.
4. Close classroom doors for proper operation of mechanical ventilation system/air exchange.
5. Consider capital plans for the future to replace air handling equipment and control systems that are past their useful service life (e.g., rooftop AHUs, univents, thermostats). Consider contacting an HVAC engineering firm for a complete building-wide assessment of all ventilation systems and controls. Based on the age, physical condition and availability of parts for ventilation components, such an evaluation is necessary to determine the operability and feasibility of repairing/replacing the equipment for future use.
6. Due to the number of mechanical ventilation components throughout the building (e.g., AHUs, univents, exhaust motors), a comprehensive preventative maintenance plan should be developed to maintain all equipment.
7. Change filters for air handling equipment (univents and AHUs) 2-4 times a year. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit.

8. Consider replacing metal filter racks with properly fitting disposable filters with an equal or greater dust-spot efficiency to eliminate the time needed to replace filters from bulk material rolls. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.

9. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).

10. 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).

11. Particular attention should be paid to thoroughly clean in/around HVAC vents and surrounding surfaces (e.g., walls, ceilings, tiles) several times a year/as needed. If ceiling tiles cannot be adequately cleaned, replace.

12. Ensure roof/plumbing leaks are repaired and replace any remaining water-damaged ceiling tiles and other building materials. Disinfect areas of water leaks with an appropriate antimicrobial, as needed.

13. Clean and disinfect mold-colonized refrigerator/freezer gaskets with a mild detergent or antimicrobial agent; if they cannot be adequately cleaned, replace.

14. Ensure that aquariums and terrariums are maintained to prevent mold growth/odors. If not in use, properly clean, dry and store.

15. 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.

16. Store any needed science chemicals/flammable materials in properly approved storage cabinets.

17. Ensure that MSDSs are available for science chemicals and that outdated and unneeded chemicals are identified and properly discarded through regular inspections.

18. Ensure that science chemicals are properly sealed/labeled.

19. Do not store chemicals/materials in lab hoods; put away after use.

20. Clean unknown debris on flat surfaces in hoods and on storage shelves to prevent chemical exposure/interactions.

21. Clean chalk and dry erase marker trays and pencil sharpening areas regularly with a wet cloth or sponge to prevent excessive build-up of dusts.

22. Replace missing/damaged ceiling tiles throughout the building. Consider long-term plans to replace tactile ceiling tiles with more easily replaceable dropped-ceiling tile system.

23. 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.

24. Clean personal fans on a regular basis.

25. Clean carpeting annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification

(IICRC). Copies of the IICRC fact sheet can be downloaded at: http://1.cleancareseminars.net/?page_id=185 (IICRC, 2005).

26. 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/actionkit.html.

27. 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.

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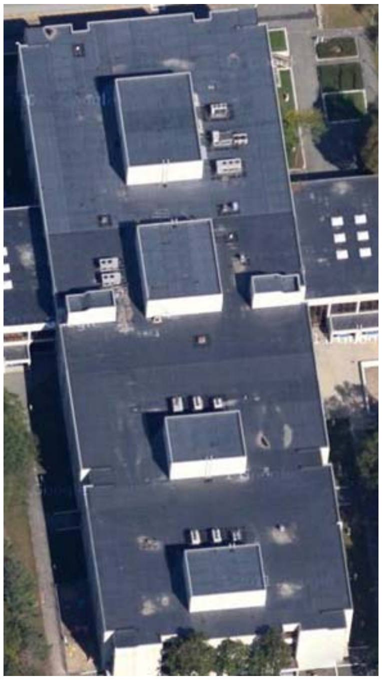
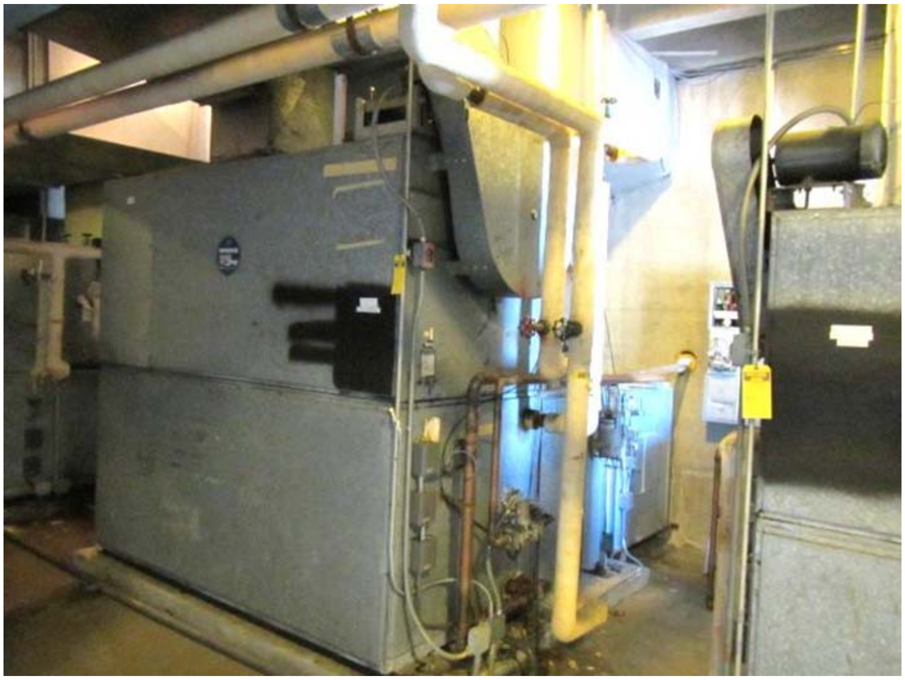
Picture 1



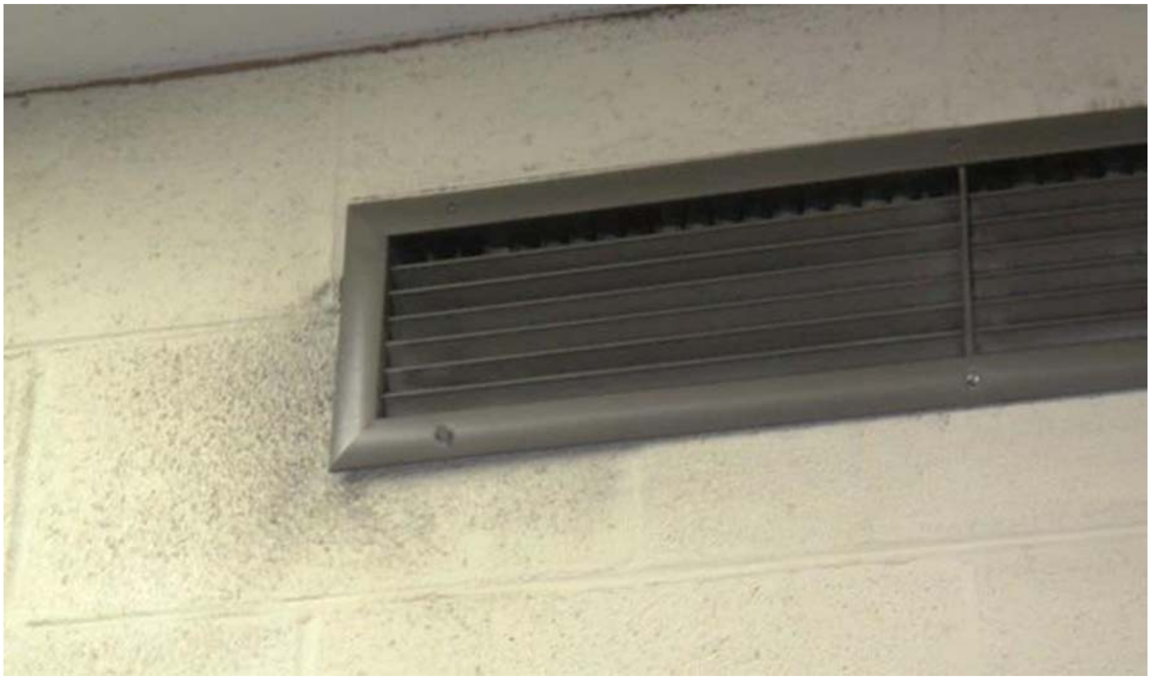
Rooftop mechanical penthouses for HVAC equipment

Picture 2



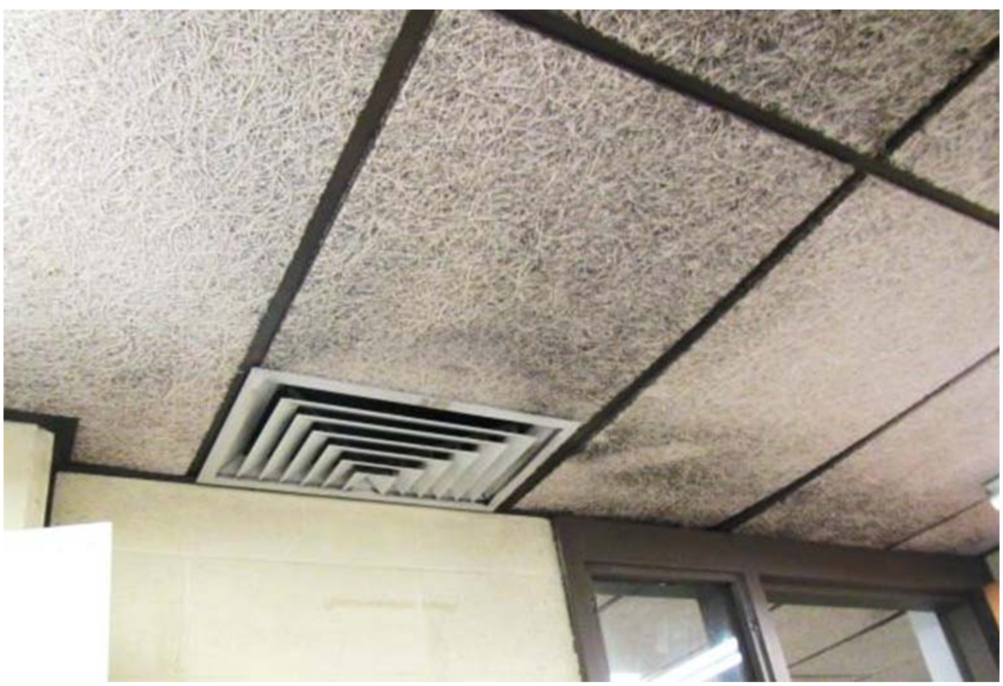
One of 13 original rooftop air handling units (early 1970s vintage)

Picture 3



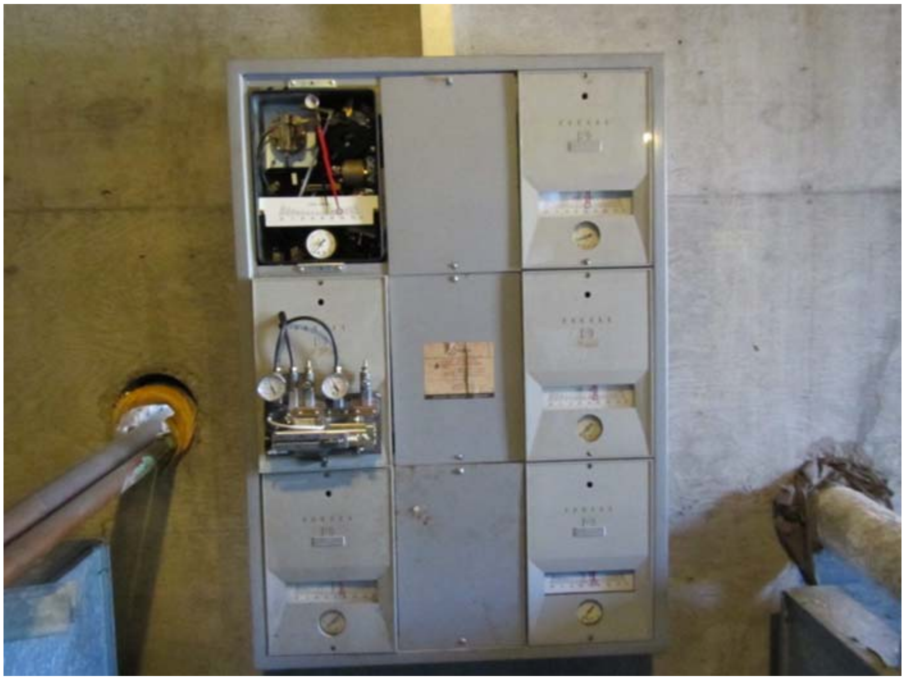
Wall-mounted supply vent, note dust/debris accumulation on wall

Picture 4



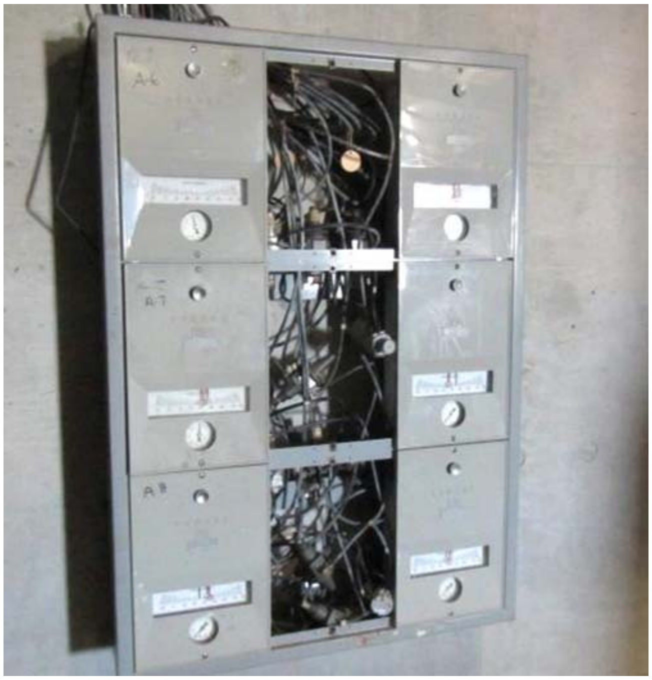
Ceiling-mounted supply vent, note dust/debris accumulation on ceiling tiles/wall

Picture 5



Antiquated pneumatic control panel for HVAC equipment, note retrofit repairs to exterior of unit

Picture 6

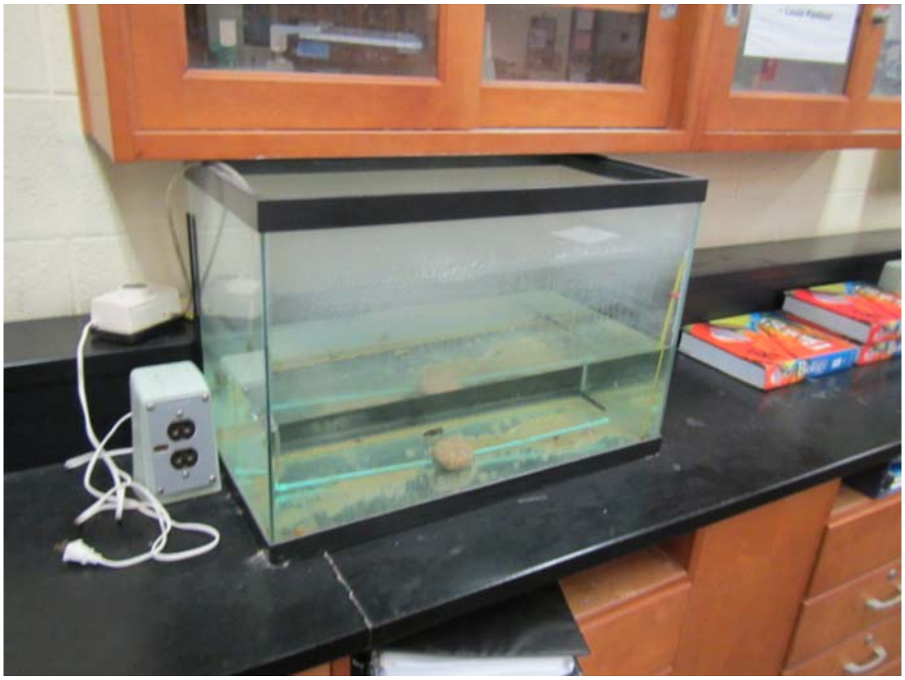


Antiquated pneumatic control panel for HVAC equipment, note missing panels for repair access

Picture 7

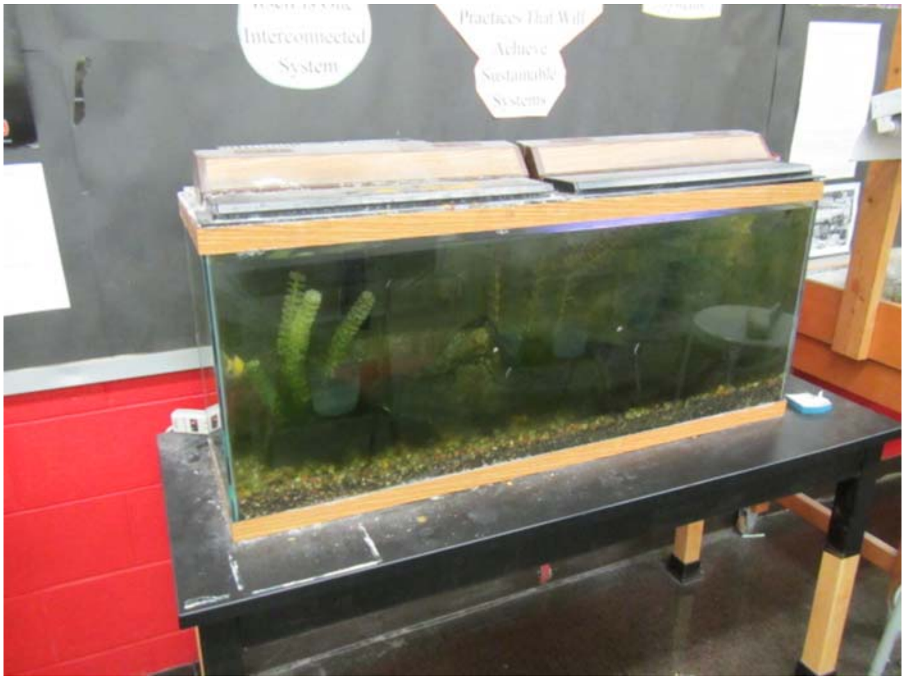
Water-damaged ceiling tiles

Picture 8



Empty aquarium with standing water

Picture 9

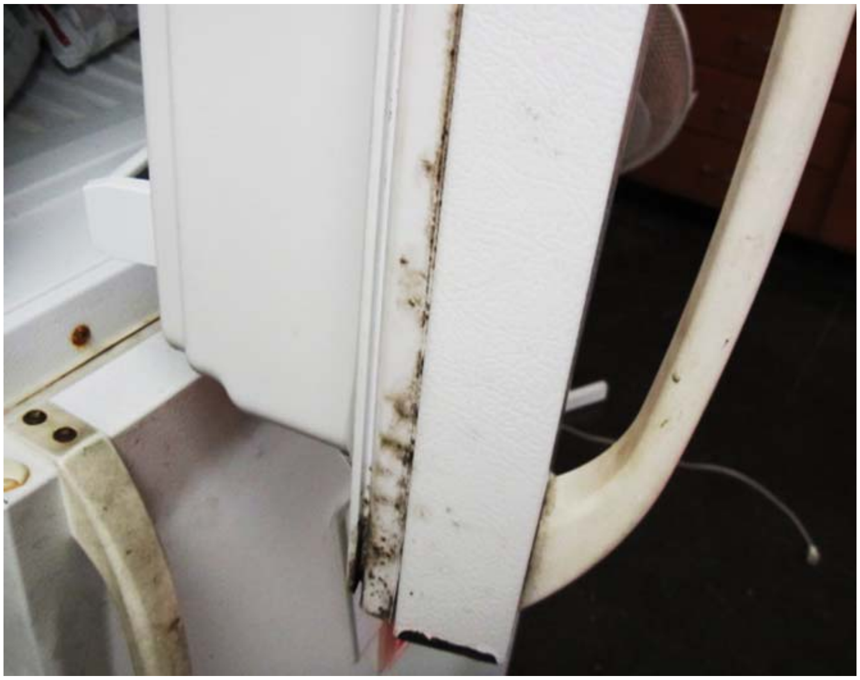


Aquarium with algal growth

Picture 10

Plants in classroom

Picture 11



Mold growth on refrigerator/freezer gasket/doors in room 370

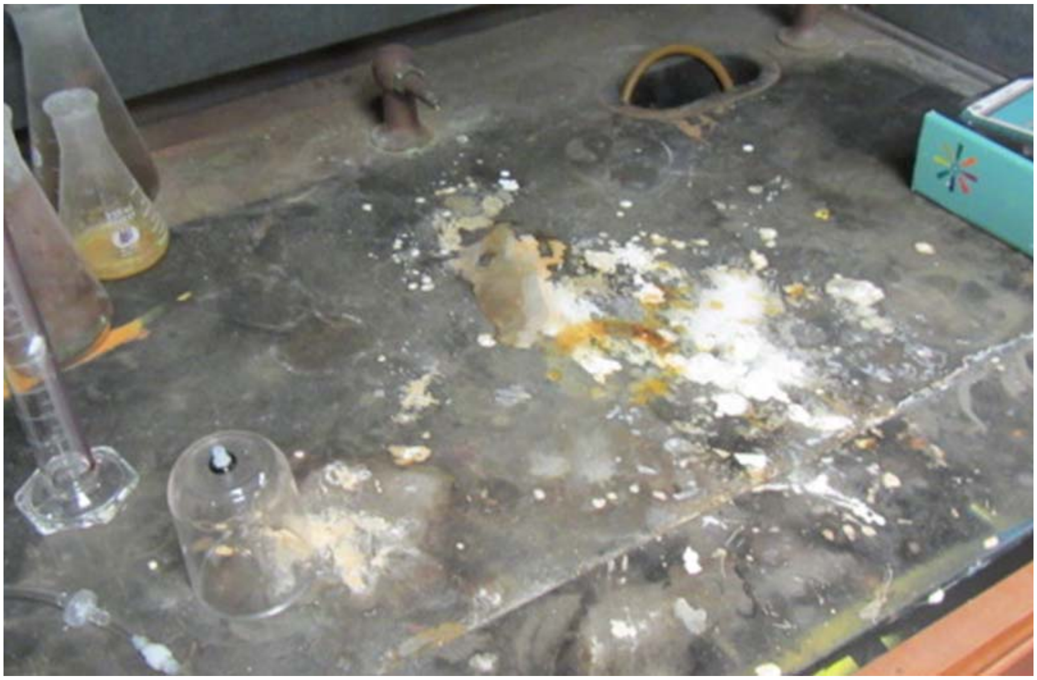
Picture 12

Items stored in unattended lab hoods

Picture 13

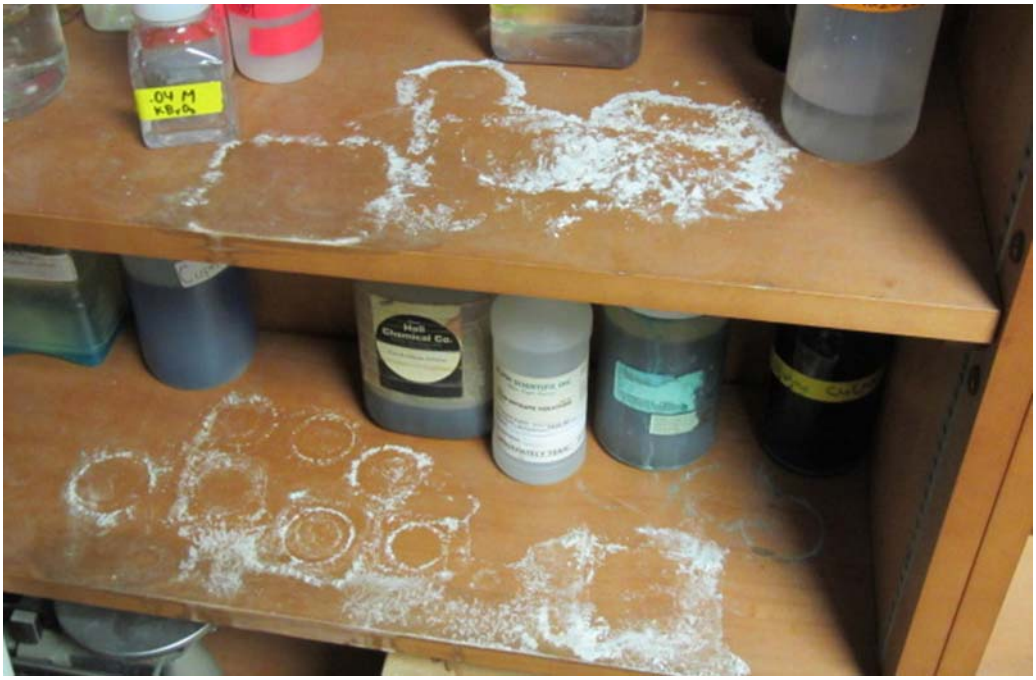
Items stored in unattended lab hoods

Picture 14



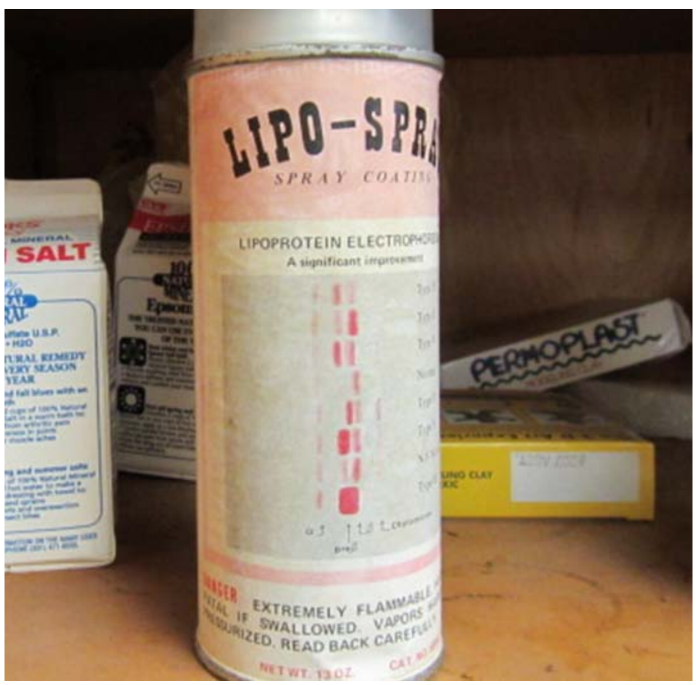
Unknown chemical debris on surface of lab hood

Picture 15



Unknown chemical debris on surface of storage shelf

Picture 16



Flammable product on open shelf, note bottom of spray can reading "Danger: Extremely Flammable"

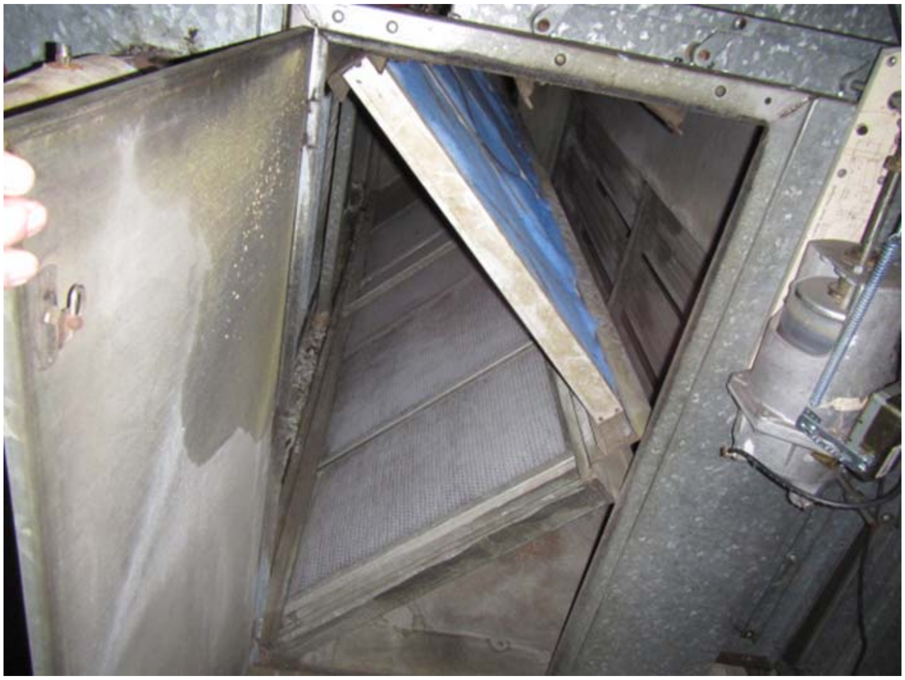
Picture 17

Improperly sealed chemical container

Picture 18

Metal racks and bulk filter medium

Picture 19

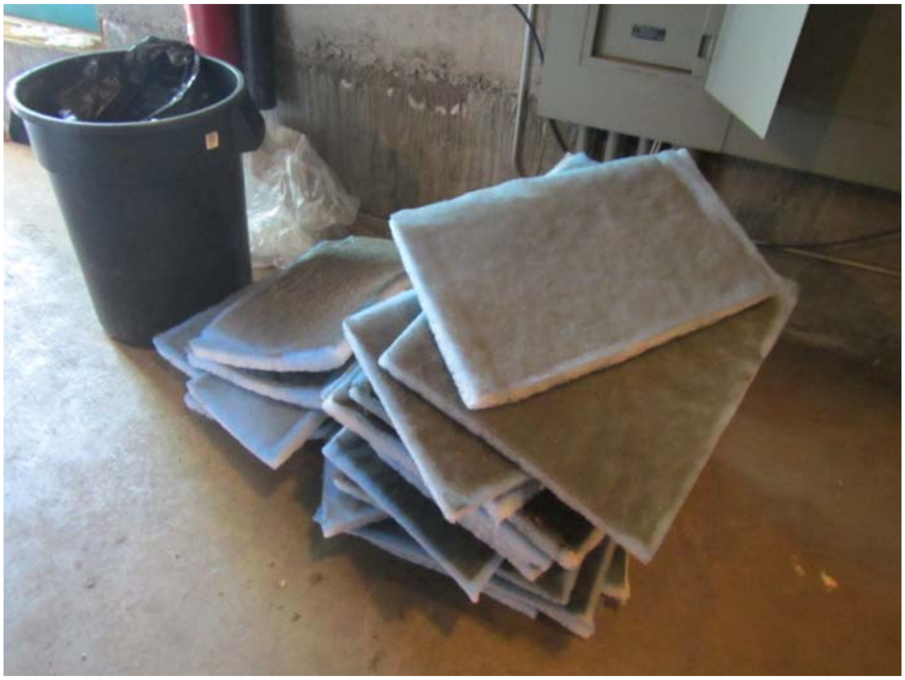


Metal racks and bulk filter medium

Picture 20

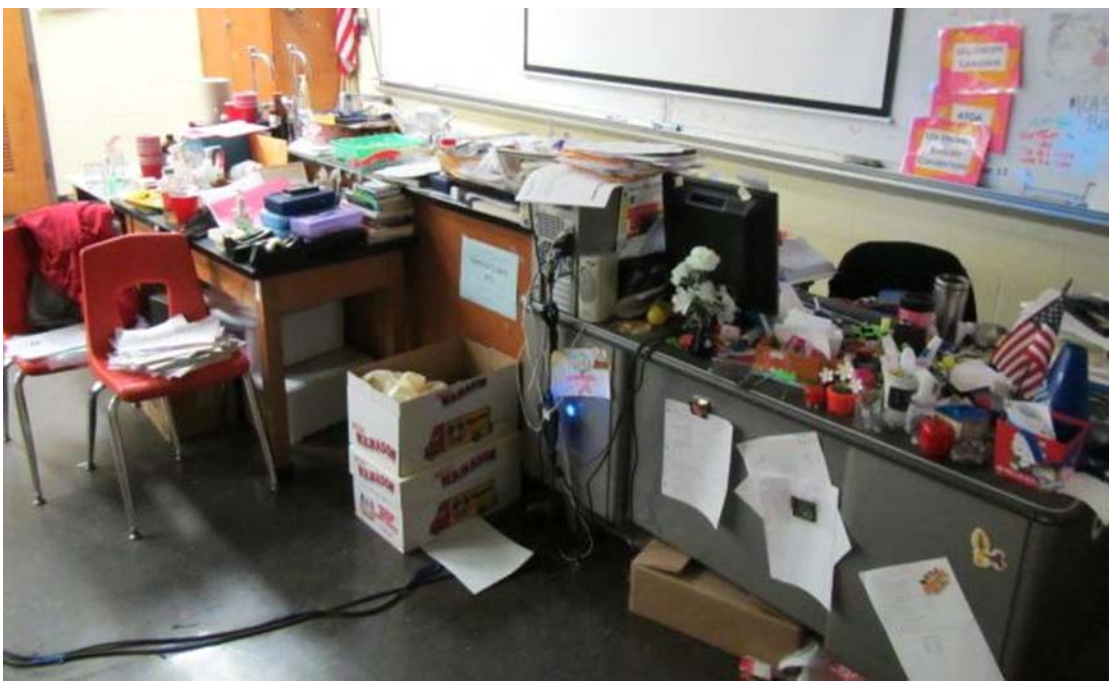
Makeshift cutting station for bulk filter medium

Picture 21



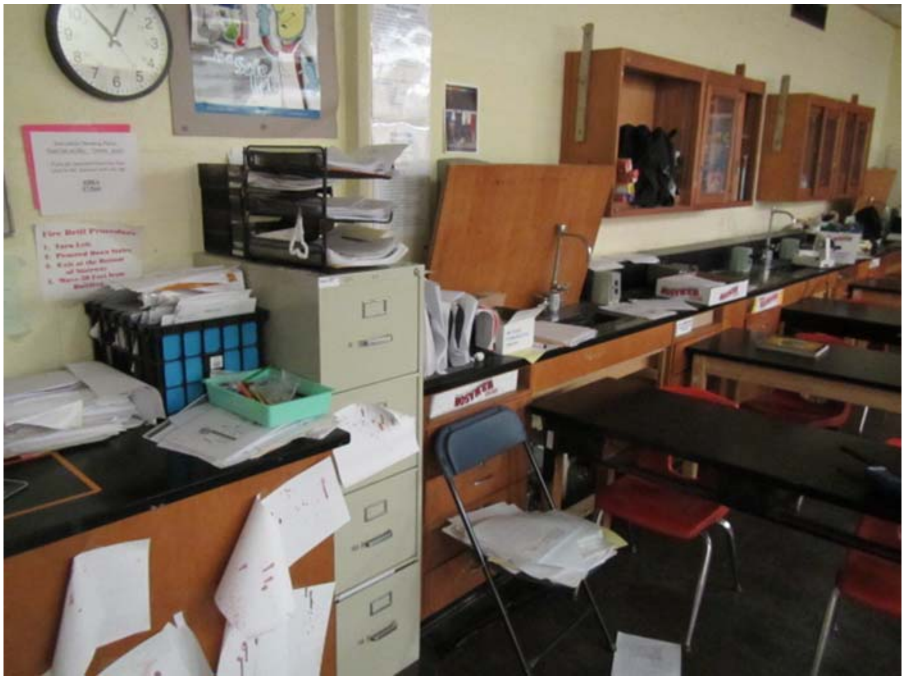
Bulk filter medium

Picture 22



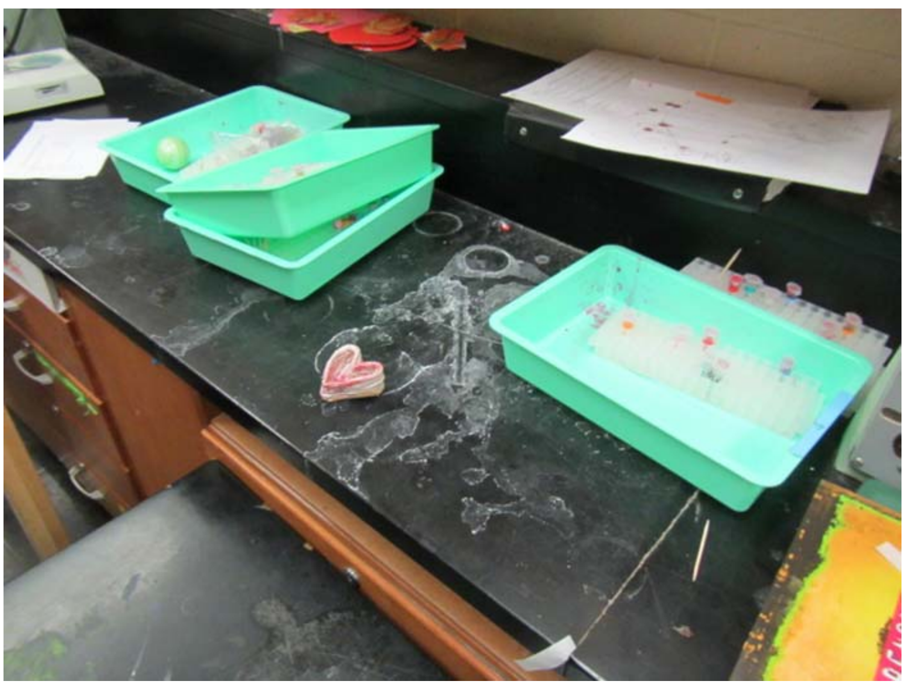
Accumulated classroom items on flat surfaces

Picture 23



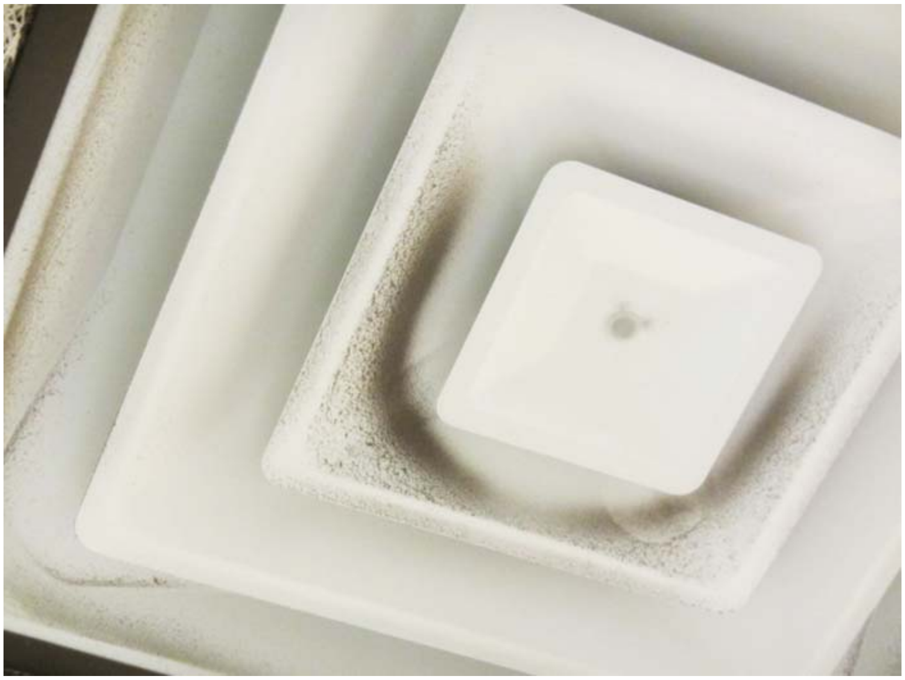
Accumulated classroom items on flat surfaces

Picture 24



Accumulated classroom items/staining/debris on flat surfaces

Picture 25



Dust/debris on supply diffuser

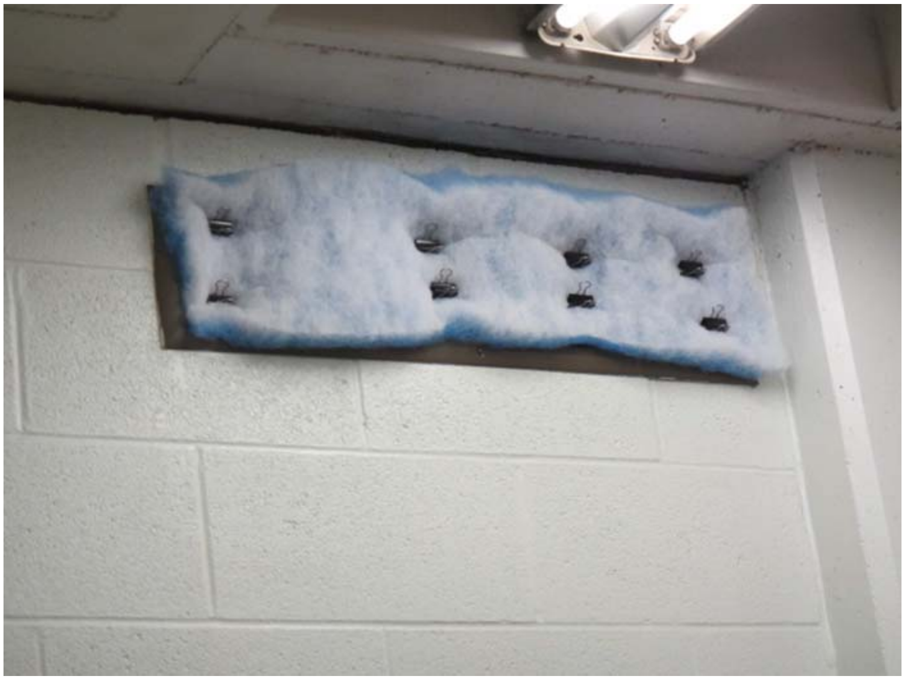
Picture 26

Dust/debris on supply diffuser and ceiling tiles

Picture 27

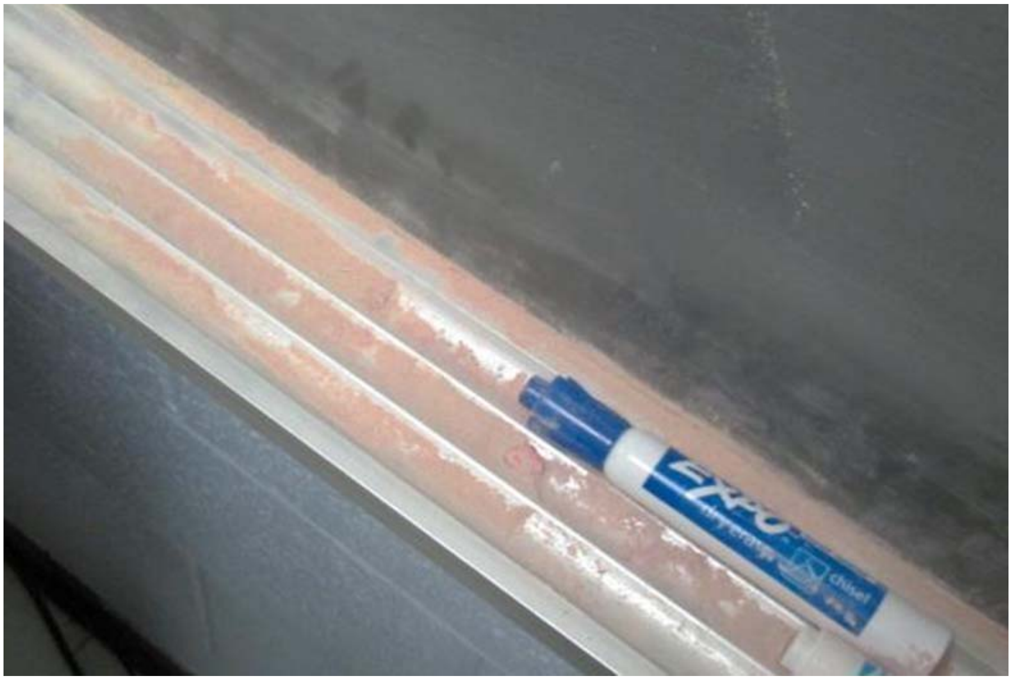
Dust/debris on supply diffuser and ceiling/wall

Picture 28



Classroom with filter media over supply vent

Picture 29



Accumulated chalk dust

Location: Braintree High School **Indoor Air Results**

Address: 128 Town Street, Braintree, MA **Date: 5/21/2014**

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 Supply	Ventilation Exhaust	Remarks
Background	395	ND	70	49	3-5					
Second Floor										
202	811	ND	74	48	3	24	N	Y	Y	Dust/debris on vents/surfaces and CTs
206	586	ND	73	46	2	0	N	Y	y	Dust/debris on surfaces
208	748	ND	73	47	3	22	N	Y	Y	Dust/debris on vents/surfaces and CTs, DO
212	485	ND	72	46	3	13	N	Y	Y	DO, plants, aqua
214	419	ND	71	47	3	1	N	Y	Y	Aqua (2)-dark with algae/standing water, terrarium, PF-dusty, accumulated items, DEM-particulate
223	460	ND	71	47	3	2	N	Y	Y	CD, W-T-W (~10 yo)

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
Aqua = aquarium
DEM = dry erase materials
W-T-W = wall to wall carpet
CT = ceiling tile
DEM = dry erase materials
CD = chalk dust
MT = missing tile
PF = personal fan
WD = water-damaged
DO = door open

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

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 Supply	Ventilation Exhaust	Remarks
226	680	ND	71	49	4	5	N	Y	Y	26 occupants gone~5 mins, DO, aqua, dust/debris on vents/surfaces
230	440	ND	71	48	3	0	N	Y	Y	Plants, aqua, filter media on supply vent, dust/debris on vents/surfaces
234	525	ND	72	47	3	3	N	Y	Y	Dust/debris on vents/surfaces and CTs
238	642	ND	72	49	3	16	N	Y	Y	Dust/debris on vents/surfaces, PF
240	742	ND	72	49	3	21	N	Y	Y	Aqua, DEM particulates
242	822	ND	73	48	3	27	N	Y	Y	Dust/debris on vents/surfaces
Third Floor										
310	864	ND	69	53	3	22	N	Y	Y	Dust/debris on vents/surfaces/ceiling
312	662	ND	68	51	2	0	N	Y	Y	Missing/damaged CTs-corner

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CD = chalk dust
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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

Location: Braintree High School **Indoor Air Results**

Address: 128 Town Street, Braintree, MA **Date: 5/21/2014**

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 Supply	Ventilation Exhaust	Remarks
314	930	ND	69	52	3	25	N	Y	Y	
316	795	ND	68	52	2	14	N	Y	Y	Cold complaints, DO, CD
321 Computer Lab	718	ND	70	49	2	0	N	Y	Y	Dust/debris on vents/surfaces and CTs, DO
323	960	ND	71	52	3	23	N	Y	Y	DO, MTs, dust/debris on CTs
326	929	ND	70	51	3	23	N	Y	Y	
328	890	ND	71	51	3	13	N	Y	Y	Dust/debris on vents/surfaces, CD
330	939	ND	70	52	3	25	N	Y	Y	DO
332	963	ND	70	52	3	26	N	Y	Y	
346	516	ND	74	47	4	1	N	Y	Y	Dust/debris on vents/CTs
348	706	ND	74	48	3	17	N	Y	Y	Dust/debris on vents/CTs, DO, PF-dusty, CD

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 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	
350	564	ND	74	46	3	14	N	Y	Y	Dust/debris on vents/wall, DO, loose CTs
366	596	ND	75	46	2	25	N	Y	Y	W-T-W
370	509	ND	75	44	3	2	N	Y	Y	Visible mold refrigerator gaskets, MT/WD CTs, unknown debris (white) in lab hood, flammable materials on shelf
376	489	ND	74	45	2	6	N	Y	Y	Items in lab hood, DO, dust/debris on vents/ceiling/wall
Guidance Main	693	ND	71	49	2	1	N	Y	Y	Dust/debris on vents/surfaces/CTs/walls
Guidance Thomas Office	637	ND	71	47	2	0	N	Y	N	W-T-W
Guidance Troy Office	619	ND	70	47	2	0	N	Y	Y	W-T-W, dust/debris on vents
Guidance Roos Office	620	ND	71	48	2	0	N	Y	Y	W-T-W, dust/debris on vents/CTs
Guidance Graofalo Office	643	ND	71	48	2	1	N	Y	Y	Dust/debris on vents/CTs

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Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
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Location: Braintree High School **Indoor Air Results**

Address: 128 Town Street, Braintree, MA **Date: 5/21/2014**

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 Supply	Ventilation Exhaust	Remarks
House 3 Office	631	ND	71	48	2	2	N	Y	Y	W-T-W, dust/debris on CTs
House 2 Office	623	ND	71	46	2	2	N	Y	Y	W-T-W, dust/debris on vents/CTs

ppm = parts per million
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ND = non detect
Aqua = aquarium
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Commonwealth of Massachusetts
Department of Public Health
Helping People Lead Healthy Lives In Healthy Communities

BUREAU OF ENVIRONMENTAL HEALTH
Indoor Air Quality Program

Guidance Concerning Proper Use and Storage of Chemicals in Schools to Protect Public Health

November 2006

The improper use and storage of chemicals in schools can lead to irritant symptoms related to indoor air quality, particularly in buildings with poor exhaust ventilation. The safety of students, faculty and school staff as well as emergency responders can all be adversely affected by the improper use and storage of chemicals. Due to the inherent danger from chemicals used in science curriculum and the variety of materials used by custodial staff, appropriate measures for proper use and storage of these materials are needed to prevent/reduce exposure. The municipal fire department in each municipality in Massachusetts has the exclusive authority to regulate the storage of flammable materials (527 CMR 14.00). The fire safety office of your municipal fire department should be consulted for assistance in compliance with these regulations.

The following guidelines are intended to serve as recommendations for the proper use and storage of these hazardous materials.

Chemical Identification

Container Labeling

Each container must be labeled with the chemical *name* of the material stored within (not chemical formula solely). Chemical names must be consistent with M.G.L. c. 111F (Hazardous Substances Disclosure By Employers, also known as the Massachusetts Right-To-Know Law) in order to facilitate the identification of the chemical(s) in case of a spill.

Material Safety Data Sheets (MSDS)

An appropriate MSDS for custodial supplies and chemicals used in science, art, photography and other programs should be obtained from the chemical supplier/manufacturer and kept in an area that is accessible to all individuals during periods of building operations in conformance with M.G.L. c. 111F. If no MSDS is available for a product because 1) the manufacturer no longer exists; 2) the manufacturer cannot be identified from the label or 3) the chemical was obtained prior to the promulgation of M.G.L. c. 111F, that material should be considered hazardous waste and disposed of in a manner consistent with Massachusetts hazardous waste regulations.

Appendix B

Proper Chemical Storage and Handling

Storage Cabinets

Flammable materials

All cabinets for storage of flammable materials must be in compliance with Massachusetts statutes, regulations and local ordinances promulgated pursuant to M.G.L. c. 148, § 13. In addition, all flameproof cabinets must meet the design and installation criteria set forth in the National Fire Prevention Association's (NFPA) latest version of NFPA 30: Flammable and Combustible Liquids Code.

Acids

Acids must be stored in a cabinet that is constructed from corrosion-resistant materials. Each acid cabinet should be vented to reduce acid vapor build up.

Chemical Storeroom Ventilation

Rooms that are designated for use as chemical storage areas must have a functioning exhaust ventilation system that operates continuously to remove fugitive chemical vapors. The local exhaust system should be ducted to the outdoors independent of the general ventilation system. Each room must also have an appropriate source of transfer (or make-up) air allowing for exhaust vents to operate efficiently. Such chemical storage ventilation systems must be in conformance with the applicable fire and building codes. Chemical storeroom exhaust vents must be inspected annually by appropriately trained individuals to ensure proper function.

Shelving

If chemicals are stored on shelving:

1. Shelving must be constructed of appropriate materials that will resist corrosion resulting from leaking materials stored on or around the shelves. For example, chemicals that are oxidizers should not be stored on wood and acids should not be stored on or near steel.
2. The shelving must be able to support the weight of stored materials.
3. Guardrails should be installed along the edge of shelving to prevent accidental slippage.

Chemical Hoods

Chemical hoods used in science programs as part of experiment preparation must be maintained in an appropriate manner in accordance with manufacturers' recommendations. Chemical hoods must be recalibrated annually by appropriately trained individuals to ensure proper function. Documentation of annual recalibration should be assessable to all building occupants. If an area is designed so the chemical hood is the sole exhaust vent for an area, the chemical hood must operate continuously during occupied hours. Chemical hoods should not be used to store unattended chemicals.

Prohibited Activities

The following chemical storage/handling practices should be prohibited to provide for the health and safety of school occupants.

- No shock sensitive material should be present in the school and should only be removed after consultation with the local fire safety office.
- No flammable materials should be stored outside flameproof cabinets.
- No non-flammable materials should be stored inside flameproof cabinets.
- Chemically incompatible materials must be separated and stored in an appropriate manner according to the manufacturer's recommendations.
- No flameproof cabinet should be vented in a manner to allow for backflow of air into the cabinet.
- No cabinet should share venting with the chemical hood.
- Acids should not be stored in cabinets made of or shelves supported by materials made of steel.
- Carpeting should not be used as floor covering in laboratories.
- Schools should not store more flammables or other liquid chemicals than are necessary to meet curriculum needs, and in no event more than a two year supply.
- No water reactive materials should be stored within 10 feet of a water source.
- Chemicals must not be stored in recycled food storage containers.

Appendix B

Chemical Spill Response Plan

Schools should have a chemical inventory and emergency response plan to ensure the safety of building occupants and emergency responders. The elements of an emergency response plan should include the following topics:

1. Procedures for evacuation of the building in the case of a spill that may to result in exposure to building occupants.
2. Contact number (911) for emergency response to a chemical spill.
3. Emergency procedures to contain the material in the location of the spill.
4. Closing of doors
5. Deactivation of the ventilation system
6. Routing of evacuation away from the spill location
7. Contact information for remediation services
8. Procedures for proper disposal of hazardous material in compliance with Massachusetts hazardous waste disposal laws.

Questions

If you have any questions concerning these guidelines, please contact:

Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
250 Washington Street, 7th Floor
Boston, MA 02108

Phone: (617) 624-5757 Fax: (617) 624-5777

Document Reviewed: August 2008

Appendix C

Braintree Public Schools
Health Services

Indoor Air / Environmental Health Form

Date: **Building:**
Time: a.m. / p.m. **Room:** **Class:**

Name: ____
Occupation: Teacher_____ Student_____ Administrator______ Secretary______
Paraprofessional______ Custodian______ Kitchen Staff______ Visitor______

Description of Problem/Concern:

____
____
____
____
____
____

Environmental Conditions (To be completed by the individual filling out this form)

Windows: Open_____ Closed_____ No Windows_____
Classroom pets: Yes_____ No_____ Type:___________________
Fish Tanks: Yes_____ No_____ Algae growth in tank? Yes__No___
Plants in room: Yes_____ No_____ Number/Type:_________________
Dust/film/coating on desks: Yes_____ No_____
Evidence of leaking water: Yes_____ No_____
Rugs in classroom: Yes_____ No_____ Whole room_____ Area rug_____
Maintenance work being done to room/area: Yes_____ No_____
Renovations to room/area: Yes_____ No_____
Construction to room/area: Yes_____ No_____
Univent blocked/obstructed: Yes_____ No_____
Other ventilation ducts blocked: Yes_____ No_____
Chemical/disinfectant use: Yes_____ No_____ Type:______________________
Dry markers: Yes_____ No_____ Type:______________________
Chalk dust in board tray: Yes_____ No_____
Tennis balls on bottom of chairs: Yes_____ No_____
Any equipment/material being stored in room/area: Yes_____ No_____ Type:______________________

Symptoms

❑ Difficulty breathing	❑ Eye irritation	❑ Increased asthma
❑ Throat irritation	❑ Cough	❑ Headache
❑ Sinus Problems	❑ Nasal congestion	❑ Light-headedness
❑ General malaise	❑ Fatigue	❑ Rash
❑ Change in mental status	❑ Other (describe)	

Appendix C

Do your symptoms exist all the time? Yes_____ No_____
Are your symptoms intermittent? Yes_____ No_____
If yes, are they associated with the time of day? Yes_____ No_____
If yes, are they associated with time of year? Yes_____ No_____
Do the symptoms abate when you leave the area? Yes_____ No_____
Do they reoccur when you return to the area? Yes_____ No_____
Do you experience the symptoms outside of school? Yes_____ No_____

When you experienced a change in health status, did you observe:
Presence of an odor? Yes_____ No_____
Presence of fumes? Yes_____ No_____
Windows? Open____ Closed____ No window_____
Room temperature? Hot_____ Warm_____ Cool_____ Cold_____
Evidence of mold in room? Yes_____ No_____

Have you seen a physician related to these symptoms? Yes_____ No_____ If yes, please explain____

Signature: ______________________________ **Date** (form completed): ___________

Nursing Assessment (To be completed by the school nurse if applicable)

Blood Pressure:________ Heart rate:________ Resp. Rate________ Breath sounds:________
Skin: Pale:________ Flushed________ Clammy________ Rash/skin irritation:____________
Sclera: Red________ Irritated________ Clear________
Abdomen: Any GI symptoms?____
History of (circle):
Asthma Mold allergy Dust allergy Frequent colds Frequent sinus infections Migraines
Other (explain)____
Medications: Are you currently taking any medications (OTC/prescription)?______________
____
____

Nurses Note____
____
____
____
____
____

Disposition: Home________ Return to class________ Referred to ____________________

Nurse's Signature____________________________ Date:________________________

Action Taken (To be completed by nurse)
Principal notified: date________________________________
Custodian notified: date ________________________________
Administration notified: date_____________________________
Original sent to Nursing Coordinator: date____________________
Form received by Nursing Coordinator:_______________________
Other:____

1/14/03