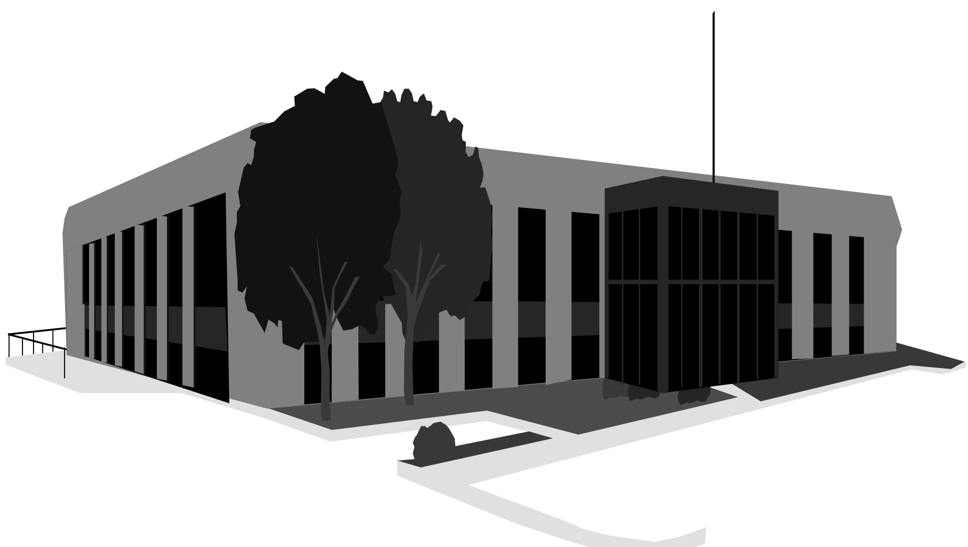
INDOOR AIR QUALITY ASSESSMENT

Reading Memorial High School
62 Oakland Road
Reading, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
February, 2000

Background/Introduction

At the request of a parent and the Reading Board of Health, the Bureau of Environmental Health Assessment (BEHA) was asked to provide assistance and consultation regarding indoor air quality issues and health concerns at Reading Memorial High School.

On November 17, 1999, a visit was made to this school by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by Suzan Donahue, Research Assistant for BEHA's ER/IAQ program. Jane Fiore, Reading Health Department, Frank Orlando, Principal, Reading Memorial High School, Herbert Marden, Reading Memorial High School Custodian and Richard Barrett, Facilities Manager, Reading Schools, accompanied Mr. Feeney and Ms. Donahue for parts of the assessment.

The school is a three-story brick complex originally constructed in the late 1940s. School officials reported that the building was renovated a number of times. For purposes of discussion in this report, results and discussion are presented by school sections: the main building A, the Tech. Ed./Art area (located in the A building), building B, building C, and a field house. The main building A contains general classrooms, offices, gymnasium, cafeteria, auditorium, and the Tech. Ed./Art area. Building B contains the media center, early learning, TV studio and lecture hall. Building C contains general classrooms, science rooms, and chemical storage. The field house was not assessed during this visit.

Methods

Air tests for carbon dioxide were taken with the Telaire Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with the TH Pen PTH 8708 Thermo-hygrometer.

Results

The school has a student population of over 1,000 and a staff of approximately 150. The tests were taken during normal operations at the school. Test results appear in Tables 1-10.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in thirty-five of eighty-nine areas surveyed, which indicates a ventilation problem in these areas of the school. Of particular note was room A-220 which had a level of carbon dioxide in excess of 800 ppm without occupancy during the air monitoring, which indicates little or no air exchange.

Fresh air in most classrooms is supplied by a unit ventilator (univent) system. (see Figure 1/Picture 1) These univents were functioning in most classrooms, however, a number were found deactivated (see tables 1-10). In several cases, univents were dismantled and/or reportedly turned off due to excessive noise. Obstructions to airflow, such as books, papers, desks and plants stored on univents were seen in a large number of classrooms. In order for univents to provide fresh air as designed, fresh air intakes must be unblocked and remain free of obstructions.

The mechanical exhaust ventilation system is in the process of being replaced with wind driven turbine fans (see Picture 2). As wind drives the turbines, exhaust air is drawn into ductwork. This system functioned as a natural/gravity exhaust system in cold weather with no wind. Warm air rises up exhaust vent ductwork from classrooms and exits the building through rooftop vents. The exhaust system in most classrooms currently consists of ducted, grated wall vents. These exhaust vents were present in rooms throughout most of the building; however, many of the vents were not drawing air or were obstructed by papers, posters, bookcases, furniture and in some cases, open doors. Some classroom exhaust vents are located on walls behind hallway doors. When doors are shut, these vents are clear. In an effort to improve airflow, classroom doors are left open, which blocks exhaust vents and ultimately interferes with the proper function of the system.

Both univents and exhaust vents were noted to have accumulated dirt, dust and debris within sections of the system in contact with airflow. In order to avoid the univent from serving as a source of aerosolized dust, dirt and debris, the sections of the unit in contact with the air stream should be regularly cleaned and have filters changed on a regular schedule.

In order to have proper ventilation with a univent 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. Information concerning servicing and balancing of the systems was not available during the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room

(SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. 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 Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings were within a range of 65^0F to 80^0F, which is outside of BEHA's recommended comfort guidelines however, most areas (84 out of 89) were within the comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^0F to 78^0F 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.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 5 to 25 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

The school has a ceiling tile system that is glued directly to the ceiling (see Picture 3). A number of hallways and classrooms have ceiling tiles which appear to be water-damaged by either water penetration through window frames (see Picture 4) or by leaks around ductwork that penetrates through the roof (see Picture 5). Replacement of these ceiling tiles is difficult, since their removal appears to necessitate the destruction of the tile, which can result in the aerosolization of particulates (see Picture 3). In addition, several classrooms appear to have water-damaged wall plaster. Water-damaged wall plaster and ceiling tiles may provide a medium for mold and mildew growth and should be replaced after a water leak is discovered and repaired. Possible mold growth was observed on ceiling tiles in classrooms A-116, C-207 and C-217.

Several classrooms contained a number of plants. Moistened plant soil and drip pans can provide a source of mold growth. Plants are also a source of pollen. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom. Room A-320 contained 4 plants located on a wooden windowsill without drip pans, which can result in mold colonization of the windowsill.

Plants should have drip pans to prevent wetting and subsequent mold colonization. Over watering of plants should be avoided and drip pans should be inspected periodically for mold growth.

Rooms A-115, B-21, B-22, and C-310 contained aquariums. Several of these aquariums had a greenish tinge, which can indicate algae growth. Algae growth can be a source of foul odors which can be irritating to some individuals. Regular maintenance and treatment of aquarium water can reduce this equipment from being a possible source of mold/algae growth as well as odors. A water cooler was noted on the carpet of the A-203 office. To avoid water damage to carpeting and/or potential mold growth, a water-resistant material such as plastic or rubber matting should be installed beneath the water cooler.

Other Concerns

Of note are the conditions under which chemicals are stored in the chemical prep room opposite classroom C-306. The use of plastic flexible hoses as vent ducts (see Pictures 6 through 8) and the potential mixing of volatile organic compounds (VOCs) with acidic materials are not acceptable methods for storing hazardous materials. The connection of these flammables storage cabinets with these vent hoses have, in BEHA's opinion, created conditions that pose an immediate danger to health and safety because of the breach of the integrity of the flameproof storage cabinet as well as the potential mixing of VOCs and strong acids. These concerns were reported to the Reading Fire Department in a letter dated November 24, 1999 (Appendix A). In many instances, improperly stored chemicals in this area pose a fire and safety hazard. Tables 11 through 14 list the chemicals found stored in the science wing which may pose health or safety concerns. The following is a list of conditions of improperly stored materials that were found in the science wing.

1. In the biology storage area, three containers of restricted use pesticides were stored in the flameproof cabinet (see Picture 9). Malathion is an organophosphate pesticide and Isotox (carbaryl) is a carbamate pesticide. Both materials can cause serious acute health effects upon exposure and can be readily absorbed through the skin on contact (USEPA, 1989). For these reasons, the US Environmental Protection Agency has classified both of these pesticides as restricted use pesticides, which curtails the sale of these materials to the general public and requires that the user of these materials be a licensed restricted use pesticide applicator.
2. The biology storage room also had a container (labeled "perchloroethylene") that appears to be a former food storage jar (see Picture 10). Perchloroethylene (also known as perc, tetrachloroethylene or PCE) is an organic solvent that can readily evaporate and can cause irritation to the eyes, nose and respiratory tract on exposure. Food containers are not acceptable for storage of PCE, since it may corrode the metal cap, resulting in the release of vapor. It is recommended that this container be disposed of in a manner consistent with Massachusetts hazardous waste disposal laws.
3. Within this room is a green metal locker that is labeled "Water Reactive Materials" (see Picture 11). The cabinet contains several water-reactive metals as well as glass tubes that were labeled "bromine". Bromine is reactive with sodium and potassium metals (NFPA, 1991) and should be stored in a separate cabinet.

4. A bottle of formic acid was found stored in the flameproof cabinet containing organic solvents. It is recommended that formic acid be stored in an acid resistant cabinet and not be stored with organic solvents (FSI, 1999).

5. The container used for storage of acids is a flameproof cabinet constructed of steel. The interior of the cabinet has become corroded from off-gassing acid vapor from bottles stored in this cabinet (see Picture 12). The storage caps on acid containing bottles have not been secured, as evident by the strong acid odor from the cabinet as well as substantial corrosion to the metal cabinet. In order to prevent metal corrosion, acids should be stored in acid proof cabinets.

6. The chemical storeroom contained an operating chemical hood. Stored in this chemical hood were several bottles of acids, a container of ethyl alcohol and one container of 1,1,2-trichloro-1,2,2-trifluoroethane. The purpose of chemical hoods is to draw aerosolized chemical vapors and odors from the work area out of the building. Chemical hoods should not be used for storage of unattended materials because this equipment can be deactivated during off-hours (Rose, S. L., 1984). If the chemical hood is deactivated, off-gassing material can penetrate into adjacent areas. Chemical hoods should be on at all times that chemicals are within the equipment. It is also good chemical hygiene practice to return stock bottles back to the storage cabinet after use.

7. Several gas cylinders of carbon dioxide and helium were found stored in a cardboard box on a shelf (see Picture 13). Under both industry regulations and good chemical storage practice standards, cylinders of compressed gas must be fixed to a wall or stand to prevent damage to cylinder valves by tipping (Rose, S. L., 1984). A damaged cylinder valve can cause an immediate and uncontrolled release of the cylinder contents and result in the

cylinder becoming a projectile. These cylinders must be secured as soon as possible to prevent accidental release and injury.

8. Several containers of elemental mercury were found stored in the organic solvent flameproof cabinet. The containers containing mercury are plastic. Organic solvent vapor can cause distortion and/or breakdown of plastic upon exposure. In addition, elemental mercury stored in plastic bottles is prone to vapor release (FSI, 1999). It is recommended that these materials be removed from this cabinet and stored appropriately.

9. A corroded metal container of phosphorous red was noted on an open shelf. Phosphorous red should be stored away from heat sources (FSI, 1999). Corrosion can undermine the integrity of a metal container, resulting in the release of the container's contents. Corrosion can also be a sign of exposure of the container to organic solvent, acid or water vapors.

10. Open containers of sulfur were stored on a shelf. These containers should be sealed with an appropriate container lid.

11. A number of empty bottles that formerly contained chemicals are stored in the back of the chemical storeroom on metal shelves (see Picture 14). Among these containers were bottles labeled with DOT placards labeled "corrosive" and "oxidizer" (see Picture 15). Each of these containers should be contained, sealed and disposed of in a manner consistent with Massachusetts hazardous waste disposal laws and regulations.

12. Chemicals are labeled by chemical formula and not name.

13. Many materials appear to be of extreme age.

14. Shelves are overloaded with chemicals, so that container labels cannot be seen without moving bottles.

15. There are a number of unlabeled containers filled with unknown materials.
16. No guardrails exist on the edge of shelves to prevent containers from accidentally slipping from shelves.

It is highly recommended that a thorough inventory of chemicals in the science department be done to assess chemical storage and disposal in an appropriate manner consistent with Massachusetts hazardous waste laws.

The woodshop is located in the basement of the Tech. Ed. Section of the A Wing. A noticeable odor of wood dust was detected in the stairwell leading to the hallway door to the wood shop. The univent system in the shop was not operating during the assessment and this area has no openable exterior windows. BEHA staff noted a significant amount of wood dust in the wood shop return vent (see Picture 16), which indicates that sawdust is aerosolized from machinery and is entrained (drawn into) by the ventilation system. The floor of the shop is also coated with wood dust in non-traffic areas (see Picture 17), indicating inadequate exhaust ventilation for sawdust generating machinery. In addition, the design of the wood shop floor tends to accumulate wood dust in the seams and grooves of the floor blocks (see Picture 18). The woodshop has local exhaust ventilation for wood cutting/sanding machines, with its ductwork located underneath the shop floor. These below floor ducts are connected to an outdoor wood dust collector. According to school personnel, the system is not being used because the ductwork is clogged with sawdust and cannot be easily cleaned since the ducts are located in the shop floor. One exhaust vent out of several in the wood shop was operating in a room used for paint storage. No other functioning exhaust vents could be found. Wood dust can be irritating to the eyes, nose, throat and respiratory system. Within the univent system are heating elements. Under certain conditions, wood dust is a fire hazard.

Also noted in the woodshop were spray paint materials in an area without exhaust ventilation (see Picture 19). Spray paint and drying materials should be located in an area with adequate ventilation. The application of spray paint and drying of painted materials should be done in the spray booth located in Art Room 44. Please note that the Art Room 44 spray booth should be equipped with a filter to prevent paint from fouling the fan blades (see Picture 20) and other parts of this equipment. A number of materials are also stored in a plain metal cabinet in the wood shop (see Picture 21). These products are flammable and should be stored in a cabinet which meets the criteria set forth by the National Fire Protection Association (NFPA) (NFPA, 1996). The print shop was found to have flammable materials stored in a metal cabinet. Print shop materials frequently contain VOCs. These products are also flammable, and should be stored in a flameproof cabinet. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999). These products can all be irritating to the eyes, nose and throat.

The woodshop also had a hallway door that did not completely close, which can result in odors and dust penetrating into the hallway and adjacent classrooms. This door should be replaced to prevent woodshop dusts/odors from spreading to adjacent areas of the school.

The art room contained a kiln with a mechanical exhaust vent (see Picture 22) and paint spray booth. Each of these machines are vented directly outdoors, however the fresh air intake for the art room univent is located in close proximity to these exhaust vents as well as directly above the exhaust vent for the wood dust collector of the wood shop (see Picture 23). This configuration of exhaust vents to the fresh air intake can result in kiln-produced pollutants, paint vapors or wood dust being entrained by the univent fresh air intake of the art room. Each of these pollutants can be irritating to the eyes, nose and respiratory system. The current Massachusetts building code requires that exhaust vents be located at a minimum 10 feet away from or 2 feet above a fresh air intake (SBBRS, 1997; BOCA, 1993). It is good ventilation design practice to separate exhaust vents from fresh air intakes.

Room C-308-6 contained several examples of taxidermy in a cabinet, which can be a source of allergenic materials for some individuals. Animal dander, fur and feathers can all be sources of respiratory irritants. Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can become easily aerosolized and also serve as an eye and respiratory irritant.

Several motor vehicles were noted parked in close proximity to univent fresh air intakes (see Picture 24). Vehicle exhaust can be entrained through ventilation systems. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL. 1996).

Graphics Room 42 was noted to have unsealed, abandoned ductwork (see Picture 25). This ductwork, if not sealed at its exit-point outside the building, can serve as a source of outside air and moisture. Abandoned ductwork can also accumulate dirt, dust and debris. Abandoned ductwork should be sealed at the outdoor exit point as well as indoors to prevent backdrafting, which can result in the introduction of dirt, dust and moisture into occupied areas from these vents.

The weight room contains an abandoned sink with an unsealed drain. The trap for this drain can dry out, which can lead to sewer gas odors penetrating into the room through the unsealed trap. Sewer gas odors can be irritating to the eyes, nose and throat.

Cigarette butts were found in a vent in the men's restroom in the A Wing. Environmental tobacco smoke can have a marked effect on indoor air quality. Environmental tobacco smoke is an indoor air pollutant, a respiratory irritant and can exacerbate the frequency and severity of symptoms in asthmatics. The most effective method of preventing exposure to environmental tobacco smoke is to have smoke free buildings. M.G.L. Chapter 270, Sec. 22 prohibits smoking in public buildings, except in an area which has been specifically designed as a smoking area (M.G.L., 1987).

Conclusions/Recommendations

The conditions noted at Reading Memorial High School raise a number of complex issues. The combination of the building design, maintenance, work hygiene practices and the condition of stored materials in the building can have an adverse impact on indoor air quality. For these reasons a two-phase approach is required, consisting of immediate measures (short-term) to improve air quality at Reading Memorial High School and long-term measures that will require planning and resources to adequately address overall indoor air quality concerns. In view of the findings at the time of this visit, the following recommendations are made:

The following **short-term measures** should be considered for immediate implementation:

1. Implement corrective actions recommended in letter to the Reading Fire Department as soon as possible (see Appendix A).
2. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.

3. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Operate univents while classrooms are occupied. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
4. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
5. Once both the fresh air supply and the exhaust ventilation are functioning, the ventilation system should be balanced.
6. Remove pesticides from flameproof cabinet and dispose of these materials in a manner consistent with Massachusetts hazardous waste laws.
7. Have a chemical inventory done in all storage areas and classrooms. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Follow proper procedures for storing and securing hazardous materials. Obtain Material Safety Data Sheets (MSDS') for chemicals from manufacturers or suppliers.
8. Store flammable materials in flameproof cabinets in a manner consistent with state and local fire codes.
9. Consider obtaining an acid resistant storage cabinet for the chemistry storeroom.
10. Maintain MSDS' and train individuals in the science department in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (M.G.L., 1983).
11. Clean wood dust from the return vent and ducts of the wood shop univent.

12. Increase cleaning of wood dust from wood shop surfaces. This can include the use of a vacuum cleaner equipped with a high efficiency particle arrestance (HEPA) filter to remove wood dust from the grooves and seams of floor blocks.
13. Install weather stripping around wood shop hallway door to prevent wood dust penetration into the hallway. Do not conduct wood shop activities with the hallway door open during hours of school occupancy.
14. Examine the possibility of providing local exhaust ventilation through the garage door as a temporary measure. Consider consulting an industrial hygienist concerning the design of temporary local exhaust ventilation in order to prevent wood dust entrainment by fresh air intakes of classrooms above the wood shop.
15. Restore the spray booth in Art Room 44. Have students spray painting in wood shop use this spray booth. Deactivate the univent in this classroom to prevent entrainment of paint vapor.
16. Once the bungholes are properly sealed, consider moving the flameproof cabinet to the industrial arts wing for use of storage of flammable materials.
17. Repair broken windows and replace missing or damaged window caulking.
18. Ensure aquariums are properly cleaned to prevent algae growth.
19. Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect with an appropriate antimicrobial where necessary. Consider reducing the number of plants in certain areas.
20. Relocate or place tile or rubber matting underneath water cooler in the A-203 office area.
21. Seal abandoned ductwork where found.
22. Seal the drain in the abandoned sink in the weight room.

23. Relocate parking area or consider posting a sign to inform staff/visitors of the close proximity to fresh air intakes and that engines must be shut off after five minutes as required by Massachusetts General Law 90:16A.

24. Prohibit smoking in this building in accordance with Massachusetts law (M.G.L. Chapter 270, Sec. 22). If a designated smoking area is established in this building, provide local exhaust ventilation consistent with recommendations of ASHRAE for smoking lounges (ASHRAE, 1989).

25. Clean chalkboards and chalktrays regularly to prevent the build-up of excessive chalk dust.

The following **long-term measures** should be considered:

1. Water-damaged ceiling tiles should be replaced. These ceiling tiles can be a source of microbial growth and should be removed. Source of water leaks (e.g., window frames and roof) should be identified and repaired. Examine the non-porous surface beneath the removed ceiling tiles and disinfect with an appropriate antimicrobial.

2. Consideration should be given to installing new ductwork at the ceiling level for the wood dust collection system. The design of the current ductwork renders it prone to clogging and is extremely difficult to clean. The installation of exposed ceiling-mounted, ductwork with airtight access doors would provide a system that can be cleaned when clogged. The design of the system should be consistent with recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH) for all wood dust producing equipment (ACGIH, 1998).

3. Extend exhaust vents for the art room kiln and spray booth to prevent entrainment by the art room univent. Consider installing a duct on the top of the wood collector to direct exhaust air from the univent fresh air intake.

4. Repairs (such as removal of ceiling tiles) would be considered a renovation that can release particulates and spores in particular, if the material is moldy. Replacement of ceiling tiles may involve glues that contain VOCs. In order to minimize building occupant exposure to construction materials during renovations, repairs should be done while the building is unoccupied.

References

ACGIH. 1998. Industrial Ventilation A Manual of Recommended Practice. 22nd ed. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

EPA, 1989. *Recognition and Management of Pesticide Poisonings*. 4th Ed. US Environmental Protection Agency, Health Effects Division, Office of Pesticide Programs, Washington, DC. EPA-540/9-88-001 March 1989.

FSI. 1999. Flinn Scientific & Biological Catalog Reference Manual 1999. Flinn Scientific Inc., Batavia, IL.

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

MGL. 1987. Smoking in Public Place. Massachusetts General Laws. M.G.L. c. 270, sec. 22.

MGL. 1996. Stopped motor vehicles; Operation of Engine; Time Limit; Penalty. Massachusetts General Laws. M.G.L. c. 90:16A.

NFPA. 1991. Fire Protection Guide to Hazardous Materials. 10th ed. National Fire Prevention Association, Quincy, MA.

NFPA. 1996. Flammable and Combustible Liquids Code. 1996 ed. National Fire Prevention Association, Quincy, MA. NFPA 30.

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

Rose, S. L. 1984. *Clinical Laboratory Safety*. Van Nostrand Reinhold, New York, NY.

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

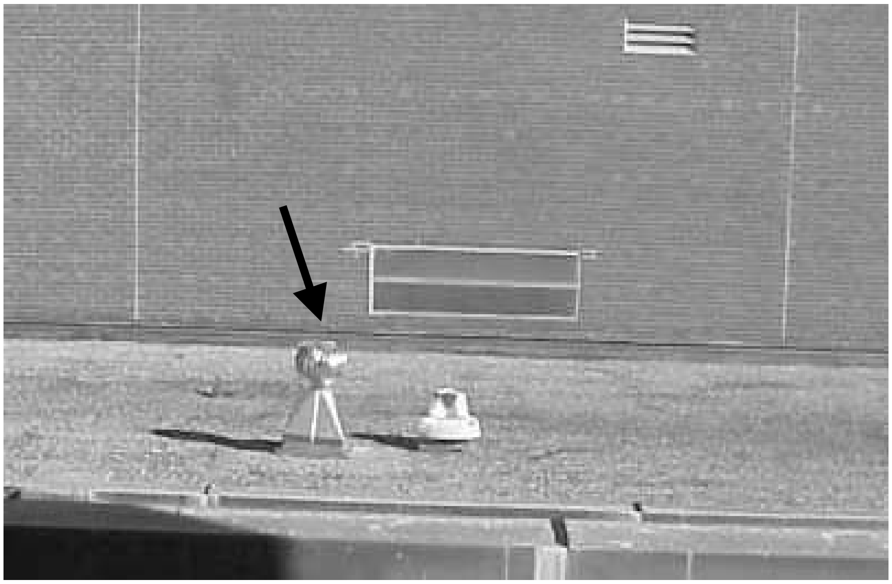
SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

USEPA, 1989. Recognition and Management of Pesticide Poisonings. 4th Ed. EPA-540/9-88-001. Washington, D.C.

Picture 1

Materials Stored on Univent Obstructing Univent Air Diffuser

Picture 2



Turbine Exhaust Fan on Roof

Picture 3

Glue Points

Missing/Water Damaged Ceiling Tiles, Note that Each Ceiling Tile Is Glued To the Ceiling

Picture 4

Water Damaged Ceiling Tiles around Window Frames

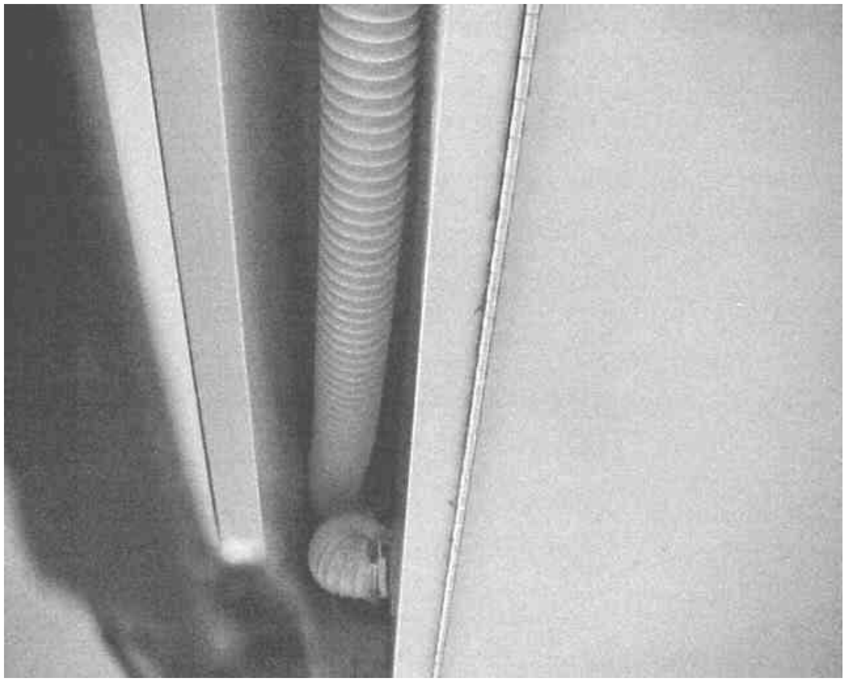
Picture 5

Water Damaged Ceiling Tiles around Ductwork

Picture 6

Plastic Flexible Hose Connecting Flameproof Cabinet

Picture 7



Plastic Flexible Hose Connecting Flameproof Cabinet

Picture 8

Plastic Flexible Hose Connecting Flameproof Cabinet To Chemical Hood Duct

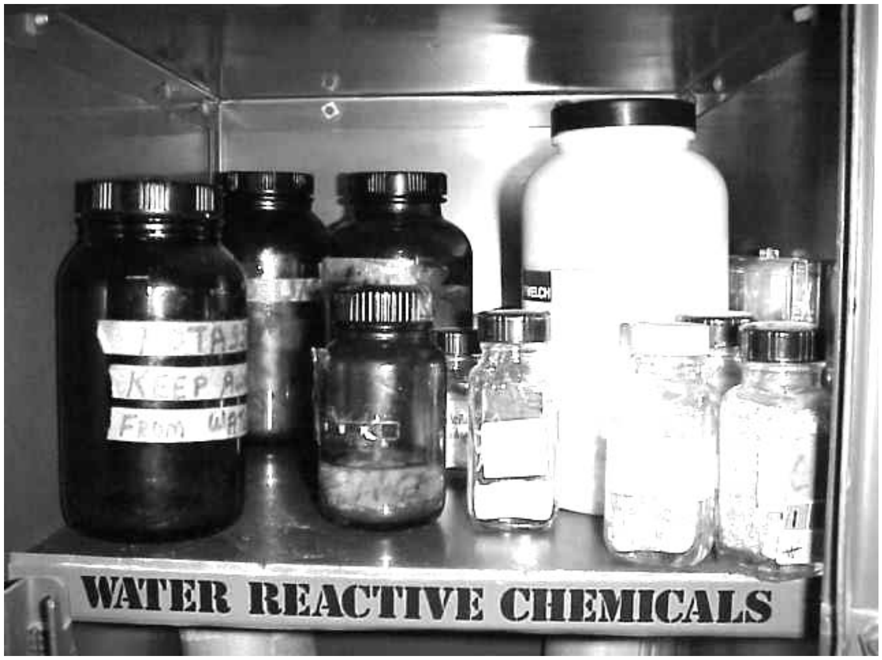
Picture 9

Restricted Use Pesticides Stored in Flammables Cabinet in the Biology Storeroom

Picture 10

Food Storage Jar Labeled "Perchloroethylene" Stored on Open Shelf in the Biology Storeroom

Picture 11



Stored Water Reactive Materials

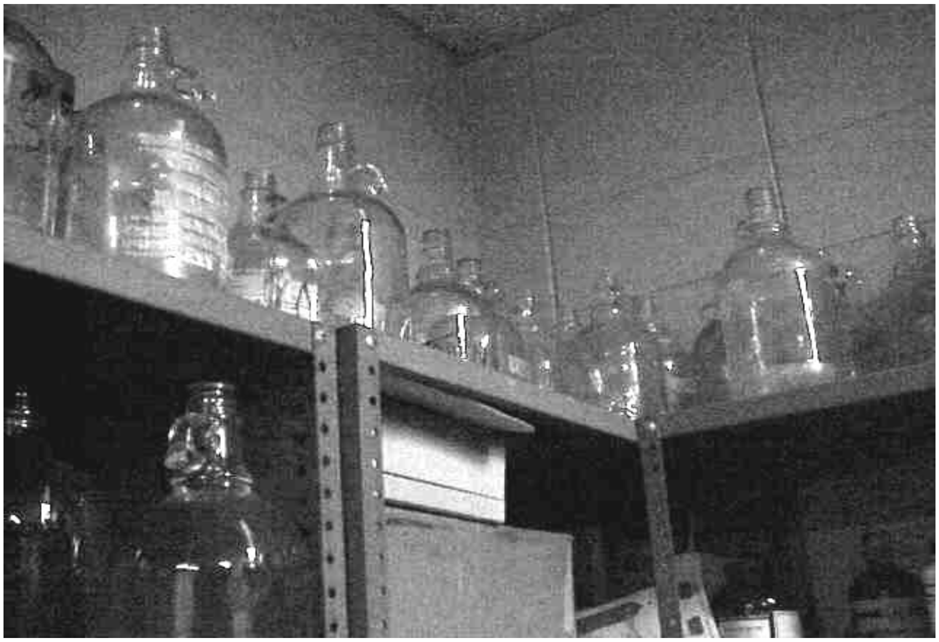
Picture 12

Acids Stored In Steel Flameproof Cabinet,
Note Corrosion of Shelves and Cabinet Walls

Picture 13

Cylinders Stored In Box on Shelf

Picture 14



Used, Unstoppered Stock Bottles Stored in Chemistry Prep Room

Picture 15

Used, Unstoppered Stock Bottles Stored in Chemistry Prep Room

Picture 16

Accumulated Sawdust Knocked from Return Vent by BEHA Inspector in the Wood Shop

Picture 17

Accumulated Saw Dust in Wood Shop

Picture 18

Accumulated Saw Dust in Seams of Floor Tiles in the Wood Shop

Picture 19

Spray Painted Materials with No Local Exhaust Ventilation

Picture 20

Spray Booth in Art Room A44, Note Fan Blades

Picture 21

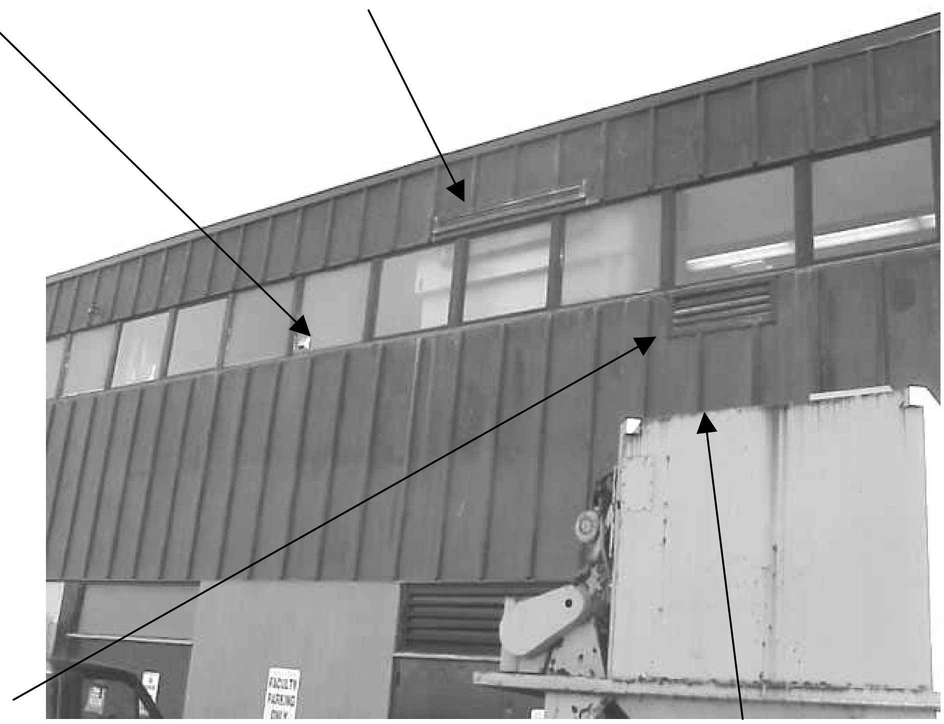
Flammable Materials Stored in Wood Shop

Picture 22

Kiln Exhaust Hose

Kiln In Art Room, Note Location of Ceiling Mounted Univent to Exhaust Vent

Picture 23

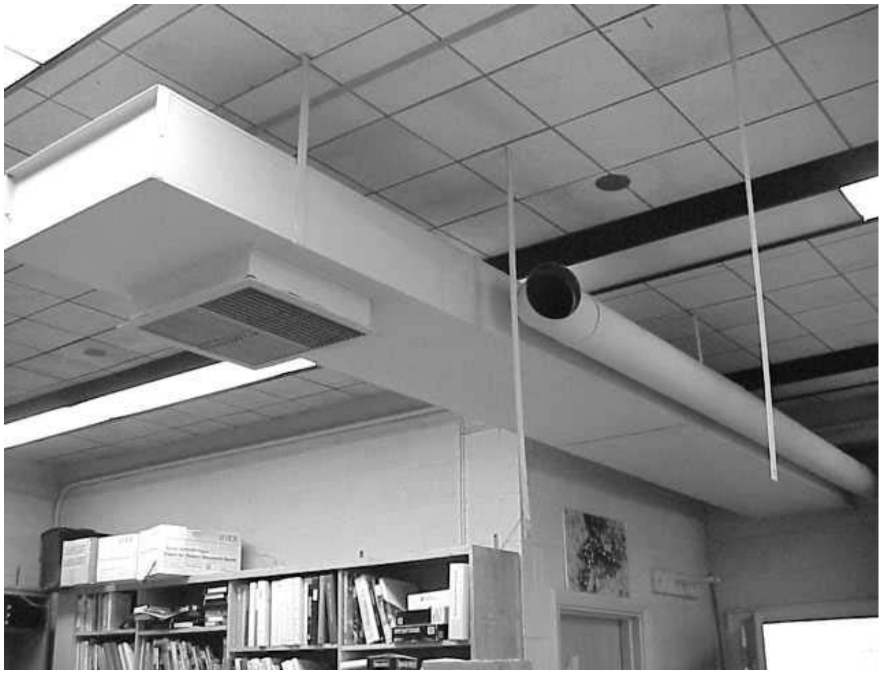


Potential Sources of Pollutants That Can Be Entrained By Art Room Univent Fresh Air Intake

Picture 24

Van Parked Next to Fresh Air Intake

Picture 25



Abandoned Ductwork in Graphics

TABLE 1

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	423	46	19					windy
Principal's Office	1208	73	17	5	yes	no	no	
A-322	1141	74	17	26	yes	yes	yes	univent blocked by books
A-320	1196	74	19	13	yes	yes	yes	univent blocked by books, 4 plants on wooden sill-no drip pan
A-318	1148	75	17	23	yes	yes	yes	9 plants, debris in exhaust vent
A-316	760	73	14	19	yes	yes	yes	univent blocked, 22 computers, 20 CT
A-314 (Office)	782	75	14	0	yes			cracked block window, mimeograph
A-312	694	73	12	4	yes	yes	yes	damaged window caulking, peeling paint/plaster
A-310	1805	76	22	24	yes	no	yes	exhaust off, 14 CT, personal fan-(off), 2 heating units, chalk dust
A-304	1331	76	15	16	yes	yes	yes	univent blocked by books, window open, 1 missing ceiling tile, 6 CT, chalk dust

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 2

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
A-302	1264	77	19	25	yes	yes	yes	wall cracks, 8 CT (around pipe), wooden sills, chalk dust
A-201	968	76	17	19	yes	yes	yes	carpet, dry erase board, 5 CT, 2 missing ceiling tiles
A-203 (Office)	697	74	14	2	yes	no	yes	carpet, water cooler on carpet, window a/c, 3 plants, 4 damaged ceiling tiles
A-203 (Inner Office)		75	15	0	yes	yes	no	carpet, 4 plants, door open, window a/c, personal fan, graffiti remover, unlabeled spray bottle
A-205	791	76	16	13	yes	yes	yes	40+ CT
A-207	827	76	18	7	yes	yes	yes	univent partially blocked, 25+ CT, 2 wall cracks, chalk dust
A-209	809	76	13	19	yes	yes	yes	univent blocked by books, exhaust off, window open, 25+ CT
A-211	691	73	12	1	yes	yes	yes	exhaust-off/backdrafting, 24+ CT
A-221	768	74	16	7	yes	no	no	window a/c, ceiling fan, 3 plants, 18 CT
A-223	754	75	16	3	yes	no	no	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 3

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Girl's Gym	592	72	14	14	yes	yes	yes (4)	
Cafeteria	885	74	16	220+	yes	yes (5)	yes (2)	4 CT, garden/pond outside air intake
Cafeteria Commons	1015	73	15	220+	yes	yes (3)	yes	debris in univent, window open
Teacher's Cafeteria	1007	74	16	8	yes	yes	yes	1 broken ceiling tile, 1 missing ceiling tile
A-101	698	65	19	0	yes	yes	yes	plant
A-103	780	68	16	16	yes	yes (2)	yes	10+ CT, water-stained plaster, debris in univent, sink
A-104	752	71	15	21	yes	yes	yes (2)	debris in univent, exterior door, wall cracks, sink
A-107	778	77	12	13	yes	yes	yes	exhaust-off/backdrafting, window open, peeling paint, freshly sprayed perfume
A-108	660	76	12	14	yes	yes (2)	yes	22 computers, 8 CT, sink, door open
A-111 Girl's Locker Room	485	73	16	~9	yes	yes (5)	yes	univent partially blocked/ - weak, damaged plaster, window fan, broken window

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 4

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
A-116	574	73	11	27	yes	yes	yes	window open, dry erase board, 8 CT (possible mold growth), missing ceiling tile, exterior door
A-115	592	74	11	7	no	yes	no	ceiling-mounted air supply, missing ceiling tile, door open
A-114	715	75	12	16	no	yes	no	13 computers, mini aquarium-shrimp larva, sink
A-112	601	76	17	5	no	no	no	prior home-ec. room, unlabelled spray bottle
TV Studio	566	69	25	2	no	yes	yes	dry erase board
Lecture Hall	579	74	22	0	no	yes	yes	univent and exhaust off, carpet
Room 21	732	75	16	5	no	yes	yes	ceiling mounted supply/exhaust-weak, (12) occupants gone, aquarium, sink, stove, unlabelled spray bottle, water cooler, exterior door, door open
Room 21 Office		75	19	0	no	no	no	8 CT
Room 22	830	76	20	13	no	yes		supply weak/off, sink., photocopier, 2 aquariums

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 5

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Library	726	74	14	~25	yes	yes	yes	water-stained ceiling tile, carpet, photocopier, window open
Library Computer Lab	725	76	17	4	no	yes		10 computers, personal fan
Assist. Principal's Office-Outer	785	76	17	2	no		yes	2 personal fans, personal heater, dehumidifier, unlabelled spray bottle
C-202	1070	77	21	16	yes	yes	yes	window open, chalk dust, ceiling-mounted exhaust
C-203	1175	77	18	18	yes	yes	yes	univent off, humidifier, dry erase board
C-204	945	78	12	1	yes	yes	yes	dry erase board-"Expo white board cleaner"
C-207	707	77	14	21	yes	yes	yes	window open, 1 CT-possible mold growth, chalk dust
C-209	690	75	10	24	yes	yes	yes	chalk dust, 4 holes in ceiling tiles
C-208	700	75	12	5	no	yes	yes	2 missing ceiling tiles, photocopier
C-215	735	76	12	9	yes	yes	yes	
C-213	1144	74	15	27	yes	yes	yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 6

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
C-212	1201	76	20	25	yes	yes	yes	carpet on platform, dry erase board
C-217	980	78	18	5	yes	yes	yes	window open, 3 CT-possible mold growth, 2 missing ceiling tiles
C-111	935	78	11	24	yes	yes	yes	2 plants, chalk dust, 1 broken ceiling tile
C-108	914	80	14	22	yes	yes	yes	lab oven, bottles labeled with chemical name vs. common name (e.g. NaCl vs. Salt), corroded faucet in chem. hood, door open
C-107	799	79	10	23	yes	yes	yes	window and door open
C-105	763	79	11	12	yes	yes	yes	6 ceiling tiles ajar, chalk dust, corrosion in chem. hood
C-109	729	77	15	23	yes	yes (2)	yes	window open, chalk dust
C-114	662	73	12	19	yes	yes	yes	window open, chalk dust
C-113	956	75	14	16	yes	yes	yes	chalk dust
Photocopier Room							yes	photocopier

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 7

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
A-327	606	70	11	0	no	yes	yes	door open
A-323	1588	70	15	8	yes	yes	yes	books on univent
A-321	681	70	9	1	yes	yes	yes	
A-319	1188	71	12	8	yes	yes	yes	books on univent, paper blocking exhaust
A-317	1090	70	11	17	yes	yes	yes	
A-315	1054	71	13	22	yes	yes	yes	
A-313	786	70	10	12	yes	yes	yes	exhaust blocked by file cabinet
A-311	1002	74	12	2	yes	yes	yes	univent off, exhaust blocked by shelf, door open
A-307	651	69	11	0	yes	yes	yes	7 CT
A-305	1461	71	13	20	yes	yes	yes	books on univent, exhaust off
A-303	761	70	12	5	yes	yes	yes	books on univent, exhaust off

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 8

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
A-301	1491	72	19	27	yes	yes	yes	books on univent, exhaust off
A-202	606	74	9	1	yes	yes	yes	10 CT, water damaged sill, photocopier
A-204	909	71	9	27	yes	yes	yes	10+ CT, water damaged sill, exhaust blocked by table
A-206	635	75	7	7	yes	yes	yes	exhaust blocked by sofa, door open
A-208 Special Ed. Main Office	590	74	15	1	yes	no	no	photocopier
Special Ed. Restroom						no	yes	exhaust off
A-218 Guidance Main Office	656	75	10	7	no	no	no	1 CT
A-220	1048	71	12	0	yes	yes	yes	exhaust blocked by file cabinet, plants
A-227	784	73	11	10	yes	yes	yes	exhaust blocked by desk
A-124 Woodshop	789	69	9	15	no	yes	yes	metal working
A-123	540	75	7	0	yes	yes	no	door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 9

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Dark Room (front)						no	yes	exhaust off
Dark Room (back)						no	yes	
A-122	880	76	9	22	yes	yes	yes	exhaust off, kiln
A-121 Art Room	906	74	9	1	yes	yes	yes	univent and exhaust off
A-119	587	75	10	0	yes	yes	yes	books on univent, exhaust off/blocked by table
A-118	591	75	5	3	no	yes	no	
A-116	600	70	5	26	yes	yes	yes	window open
A-117								abandoned sink
C-311	914	71	12	13	yes	yes	yes	exhaust off, water damaged ceiling tiles over window, molding plant in a tray
C-308 – 6								animals – cabinet

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

TABLE 10

Indoor Air Test Results – Reading Memorial High School, Reading, MA – November 17, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
C-307	530	68	10	2	yes	yes	yes	plant over univent, 8 missing ceiling tiles
C-307	516	68	5	23	yes	yes	yes	exhaust off
C-304				18	yes	yes	yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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%

Table 11

Chemicals Stored in Biology Storeroom Opposite C349

Chemical Name	Estimated Quantities
Benzene	1 1-gal. metal container
Isotox (carbaryl) 5%	1 8 fl. oz. bottle 1 1-pt bottle
Malathion 50 %	1 1-pt
Paint Thinner	3 1-gal. container
Xylene	2 1-gal. container

Table 12

Chemicals Stored in Organic Solvent Flameproof Cabinet in Chemistry Storeroom Opposite C306

Chemical Name	Estimated Quantities
1,2-dichloroethane	1 bottle
Benzene	1 500-ml bottle
Benzyl alcohol	1 bottle
Carbon tetrachloride	1 8-pint bottle
Chloroform	1 bottle
Ethyl alcohol	1 bottle
Ethylene glycol	8 1-pint bottles
Formic acid 90%	2 500-ml bottles
Hexanes	1 8-pint bottle
Isoamyl alcohol	2 bottles
Isobutanol	1 1-quart bottle
Kerosene	1 bottle
Kerosene	1 bottle
Mercury	several bottles (estimated over 30 lb.)
Methyl alcohol	1 bottle
Nitrobenzene	1 bottle
Pentyl alcohol	1 1-pint bottle
Xylene	1 bottle

Table 13

Chemicals Stored in Acid Flameproof Cabinet in Chemistry Storeroom Opposite C306

Chemical Name	Estimated Quantities
Phosphoric acid	multiple bottles
Hydrochloric acid	multiple bottles
Nitric acid	multiple bottles
Sulfuric acid	multiple bottles

Table 14

Chemicals Stored in Green Locker Labeled "Water Reactive Materials in Chemistry Storeroom Opposite C306

Chemical Name	**Estimated Quantities**
Sodium	4 bottles
Calcium	5 bottles
Barium	1 bottle
Potassium	1 bottle
Strontium	1 bottle
Bromine	multiple glass tubes
Silver nitrate	6 bottles

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
Bureau of Environmental Health Assessment
250 Washington Street, Boston, MA 02108-4619

ARGEO PAUL CELLUCCI
GOVERNOR

JANE SWIFT
LIEUTENANT GOVERNOR

WILLIAM D. O'LEARY
SECRETARY

HOWARD K. KOH, MD, MPH
COMMISSIONER

November 24, 1999

Jack Mooney, Assistant Chief
Reading Fire Department
757 Main Street
Reading, MA 01867

Dear Chief Mooney,

As you know, the Massachusetts Department of Public Health, Bureau of Environmental Health Assessment conducted an indoor air quality assessment at the Reading High School on November 17, 1999. During the course of this assessment (conducted with Jane Fiore of the Reading Board of Health) conditions in the chemical storage area in the first floor of the science wing C at the high school were evaluated. This storeroom contains two flammables storage cabinets. One cabinet contains a number of volatile organic compounds (VOCs); the other contains a number of stored bottles containing strong acids. Of concern is the connection of these cabinets by a flexible plastic hose (see Pictures 1 and 2). The flammables storage cabinet containing the strong acids is connected by a second plastic hose to the vent of the chemical hood (see Picture 3).

As you probably know, according to the National Fire Protection Association (NFPA), it is recommended that flammables storage cabinets be constructed in a manner to prevent fire from coming in contact with stored chemicals. In addition, it is recommended that if a flammables storage cabinet is connected to a vent system, the vent system should not be constructed in a manner to provide an oxygen source to the interior of the cabinet. The NFPA does not require venting in flammable storage cabinets, however, if venting is done, it must be vented directly outdoors and in a manner not to compromise the specific performance of the cabinet (NFPA, 1996).

It appears that the purpose of these hoses is to draw evaporating VOCs and acids from these cabinets. The exposure of VOCs to strong acids can result in accidental chemical reactions. If a fire were to occur in this storeroom, these plastic hoses would readily melt and expose the VOCs contained in the cabinet to fire, which then can serve as a mechanism to spread fire.

The connection of these flammables storage cabinets with these vent hoses have, in the BEHA opinion, created conditions that are an immediate danger to health and safety because of the breach of the integrity of the flammables storage cabinet as well as the potential mixing of VOCs and strong acids.

We recommend that the following actions be taken to remediate this hazard:

1. Disconnect the flexible hoses from the flammables storage cabinet. Reseal the bungholes of the flammables storage cabinet with the original bungs. If the original bungs cannot be located, contact the cabinet manufacturer to obtain replacements.
2. Reseal the ductwork of the chemical hood to render this duct airtight.

We recommended that these steps be taken as soon as possible. We hope you find this information helpful. Please feel free to contact us at (617) 624-5757.

Sincerely,

Michael A. Feeney, R.Ph., J.D., C.H.O.
Chief, Emergency Response/Indoor Air Quality Program
Bureau of Environmental Health Assessment

cc/ Suzanne Condon, Dir., BEHA
Martha Steele, Dep. Dir., BEHA
Cory Holmes, ER/IAQ, BEHA
Suzan Donahue, ER/IAQ, BEHA
Jane Fiore, Reading Board of Health
John Orlando, Principal, Reading High School

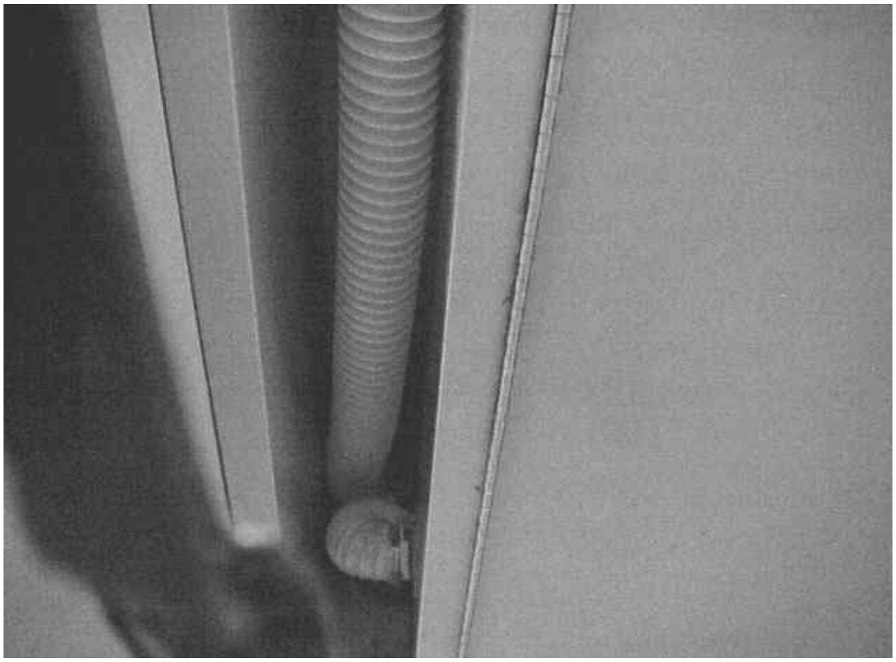
References

NFPA. 1996. Flammable and Combustible Liquids Code. 1996 ed. National Fire Protection Association, Quincy, MA. NFPA 30.

Picture 1

Plastic Flexible Hose Attached to Flammables Storage Cabinet Containing Volatile Organic Compounds

Picture 2



Lower section of Hose in Depicted in Picture 1 Connected to Flammables Storage Cabinet Containing Strong Acids

Picture 3

Plastic Flexible Hose Connecting Flammables Storage Cabinet to Exhaust Vent Ductwork of the Chemical Hood