INDOOR AIR QUALITY ASSESSMENT

Oaklandvale Elementary School
226 Main Street
Saugus, Massachusetts 01906

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
August 2006

Background/Introduction

At the request of parents, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH) was requested to provide assistance and consultation regarding indoor air quality at each of Saugus's public schools, the majority of which took place over the spring of 2006. These assessments were jointly coordinated through Sharon McCabe, Director of the Saugus Health Department, and Ralph Materissi, Building Maintenance Director, Town of Saugus. The remainder of the Saugus public schools will be scheduled over the fall of 2006.

On May 2, 2006 a visit to conduct an assessment of the Oaklandvale Elementary School (OES) was made by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ). The OES is a one-story red brick building constructed in the early to mid 1960s. The roof was reportedly repaired during the summer of 2005. The building contains general classrooms, library, office space, kitchen and an all-purpose room used as the cafeteria, gymnasium and auditorium. Windows are openable throughout the building, the majority of which were reportedly replaced over the last several years.

The OES was previously evaluated in January of 1998 by Covino Environmental Associates, Inc. (Covino), an environmental consultant. Covino inspected mechanical ventilation equipment and conducted general IAQ testing for carbon monoxide, carbon dioxide, volatile organic compounds and respirable particulates. Covino made the following recommendations based on their findings:

- Increase supply of outdoor air to occupied spaces and operate univents during occupation;
- Inspect and replace univent filters;
- Clean the interior of univents;
- Inspect mechanical equipment and pneumatic system of univents for proper operation;
- Clean exhaust grilles in classrooms and remove materials obstructing airflow;
- Investigate the feasibility of extending classroom ductwork to the front face of the closet to improve airflow, and
- Inspect the condition of internal components (filters, dampers, coils, etc.) of rooftop air handling unit (Covino, 1998a).

In September of 1998, Covino conducted air monitoring for airborne asbestos fibers and airborne mold at the OES. The Covino report indicated that no asbestos was detected in any of the air samples taken. Mold sampling indicated that indoor concentrations of mold were not significantly higher than outdoors and that species found indoors were comparable to those found outdoors (Covino, 1998b). No corrective actions were recommended by Covino.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Hnu, Model 102 Snap-on Photo Ionization Detector (PID). CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The OES houses approximately 250 students in grades K-5 and has a staff of approximately 20. Tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million parts (ppm) in all occupied areas surveyed, indicating poor air exchange throughout the school. Fresh air in classrooms is supplied by a unit ventilator (univent) system (Picture 1). A univents is designed to draw air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and return air through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed and filtered, then heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Fresh air intakes for univents in interior rooms are located on the roof. Air is distributed via louvered ceiling diffusers (Picture 3). Univents were operating in all but one classroom examined during the assessment. Univents are reportedly original equipment, approximately 40 to 45 years old. Univents of this age can be difficult to maintain because replacement parts are often unavailable.

Exhaust ventilation is provided by vents located in the ceilings of coat closets (Picture 4) and are powered by rooftop motors. Air is drawn into the coat closet from the classroom via undercut closet doors (Picture 5). MDPH staff did not detect any draw of air from the exhaust vents at the time of the assessment. A call was made to the town electrician who determined that exhaust ventilation in these areas was inadvertently deactivated by a wall panel (Picture 6). The location of the closet vents also allows them to be easily blocked by stored materials (Picture 7). However, it appears that an attempt was made to increase airflow into the coat closet by installing small passive vents in the front of the coat closets (Picture 8). In order to function properly, exhaust vents must be activated and remain free of obstructions.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. 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. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment. However in subsequent conversation with Ralph Materissi, Building Maintenance Director, Town of Saugus, an HVAC engineering firm, Johnson Controls Inc., was contracted to inspect and make recommendation for repair of mechanical ventilation systems.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). 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 because a majority of occupants is young and considered 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 on carbon dioxide see Appendix A.

Temperature readings ranged from 69^{o} F to 76^{o} F, which were within or very close to the MDPH recommended comfort the day of the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F. 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 measurements ranged from 37 to 58 percent, which were within or close to the lower end of the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity would be expected to drop below comfort levels during the heating season. 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 a number of areas (Picture 9), indicating evidence of historic leaks. The assessment occurred during a period of moderate to heavy rainfall; no leaks were reported or observed at that time. Water damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired.

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

Plant debris (and bird seed from a feeder outside of room 18) was observed on the inner lip of univent air intakes (Picture 10) on the exterior of the building. The design of the fresh air intakes allows for debris to accumulate inside the grilles. If wetted repeatedly, this can create conditions for mold growth, which can in turn be drawn into univents and distributed into occupied areas.

Several other potential pathways for moisture to enter the building were identified. CEH staff observed spaces between wall/window panels in exterior walls (Pictures 11 and 12) and cracks in brickwork toward the rear of the building (Pictures 13). Repeated water penetration can result in the chronic wetting of building materials, which can potentially lead to microbial growth. In addition, these breaches in the building envelope can provide a means of egress for pests/rodents into the building.

Inactive bird's nests were seen in a few classrooms (Picture 14). Nests can contain bacteria and may be a source of allergenic material. Nests should be placed in resealable bags to prevent aerosolization of allergenic material.

Other Concerns

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products 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 school environment, CEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution 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).

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 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (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, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels.

Outdoor carbon monoxide concentrations the day of the assessment ranged from 1-3 ppm. Carbon monoxide levels measured in the school were non-detect or ND (Table 1).

As previously mentioned, the US EPA also established NAAQS for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 9 $\mu g/m^3$. PM2.5 levels measured indoors ranged from 8 to 29 $\mu g/m^3$ (Table 1). PM2.5 measurements were below the NAAQS of 65 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are 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 determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC measurements throughout the building were also ND (Table 1).

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC-containing products. While no measurable TVOC levels were detected in the indoor environment, VOC-containing materials were noted. Several classrooms contained dry erase boards and dry erase board markers. 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.

Several other conditions that can affect indoor air quality were noted during the assessment. A slight natural gas odor was detected in the boiler room. CEH staff reported this finding to Mr. Materissi, who contacted the school’s utility company, Keyspan. A Keyspan representative arrived shortly after and identified two small hairline fissures in the natural gas piping, which were subsequently sealed by the Saugus Building Department staff member under the direction of Keyspan (Picture 15).

A number of exhaust/return vents and personal fans had accumulated dust (Pictures 4 and 16). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. Missing ceiling tiles were observed in a few areas (Picture 17). Missing ceiling tiles can serve as a means for odors, dusts and particulates to migrate into occupied areas.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to prevent excessive dust build-up.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 18). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and off-gas TVOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Conclusions/Recommendations

In view of the findings at the time of the assessment, the following recommendations are made:

1. Make permanent repairs to gas pipes in boiler room.
2. Continue with plans to have an HVAC engineering firm evaluate the mechanical ventilation systems. Examine each univent for function. Survey classrooms for univent function to ensure the calibration/function of univent fresh air control dampers throughout the building.
3. Operate all ventilation systems that are operable throughout the building (e.g., gym/cafeteria, offices, classrooms) continuously during periods of school occupancy and independent of thermostat control. To increase airflow in classrooms, set univent controls to “high”.
4. Consider installing ducted exhaust grills to the face of coat closets to improve air exchange.
5. Remove all blockages from univents to ensure adequate airflow.
6. Remove all blockages from the vicinity of coat closet exhaust vents to ensure adequate airflow.
7. Consider having ventilation systems re-balanced every five years by an HVAC engineering firm.
8. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.

9. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
10. Relocate bird feeders away from univent air intake.
11. Ensure roof and /or plumbing leaks are repaired and replace any remaining water-stained ceiling tiles.
12. Seal spaces around exterior window frames and wall panels.
13. Seal/repair cracks in brickwork.
14. Clean and disinfect univent fresh air intakes regularly. Consider replacing univent fresh air intake grills with an alternative design to prevent the accumulation of debris.
15. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Relocate plants away from the air stream of univents.
16. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
17. Replace missing ceiling tiles.

18. Clean exhaust vents periodically to prevent excessive dust build-up.

19. Consider discontinuing the use of tennis balls on walker legs to prevent latex dust generation. Alternative "glides" can commonly be purchased from office supply stores, see Picture 19 for an example.

20. Consider adopting the US EPA document, "Tools for Schools" (US EPA, 2000b), to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.

21. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website at http://www.state.ma.us/dph/CEH/iaq/iaqhome.htm.

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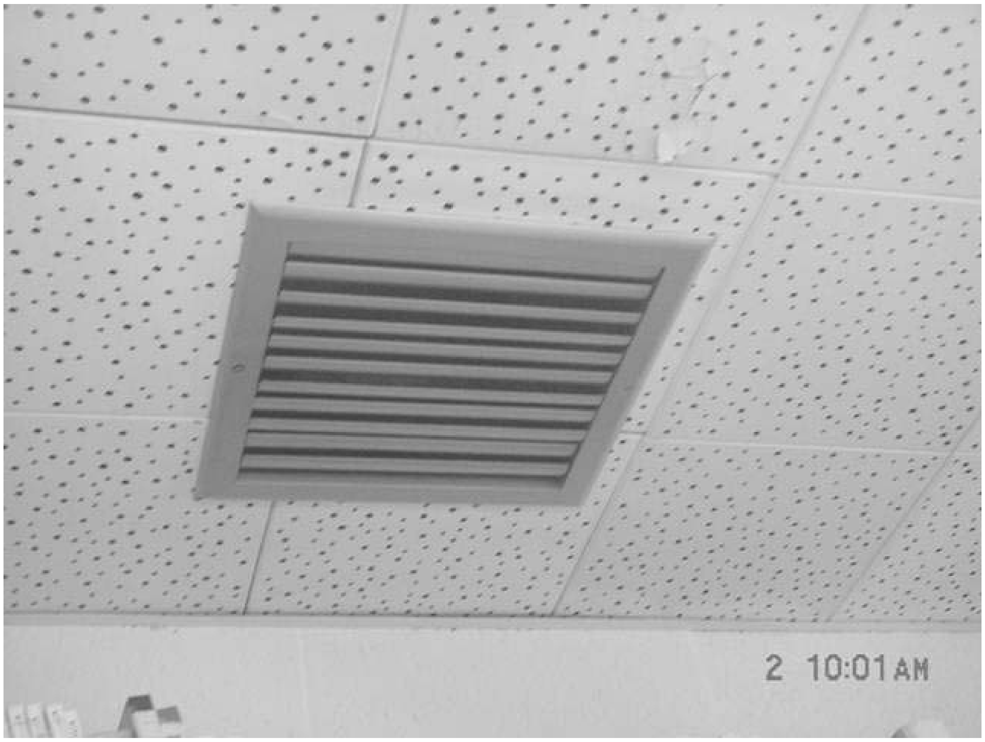
Picture 1

Classroom Univent, 1960s Vintage, Note Plants near Air Diffuser

Picture 2

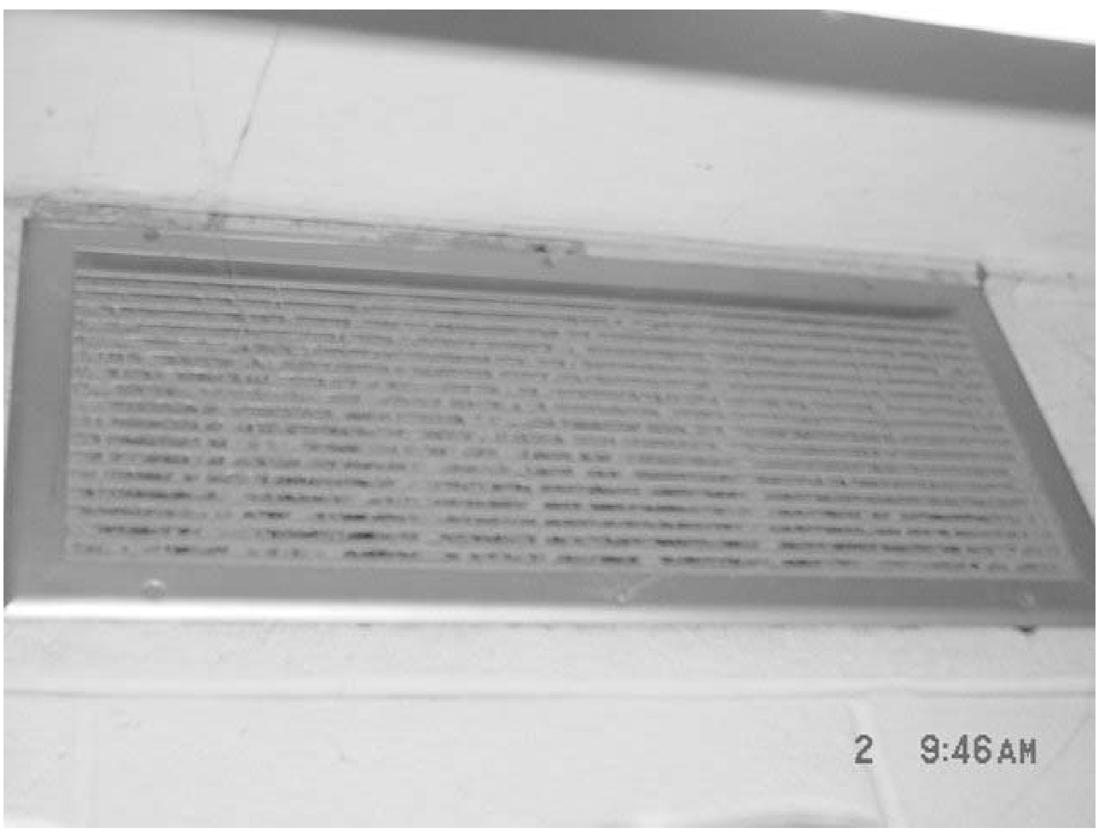
Univent Fresh Air Intake

Picture 3



Ceiling-Mounted Univent Louvers

Picture 4

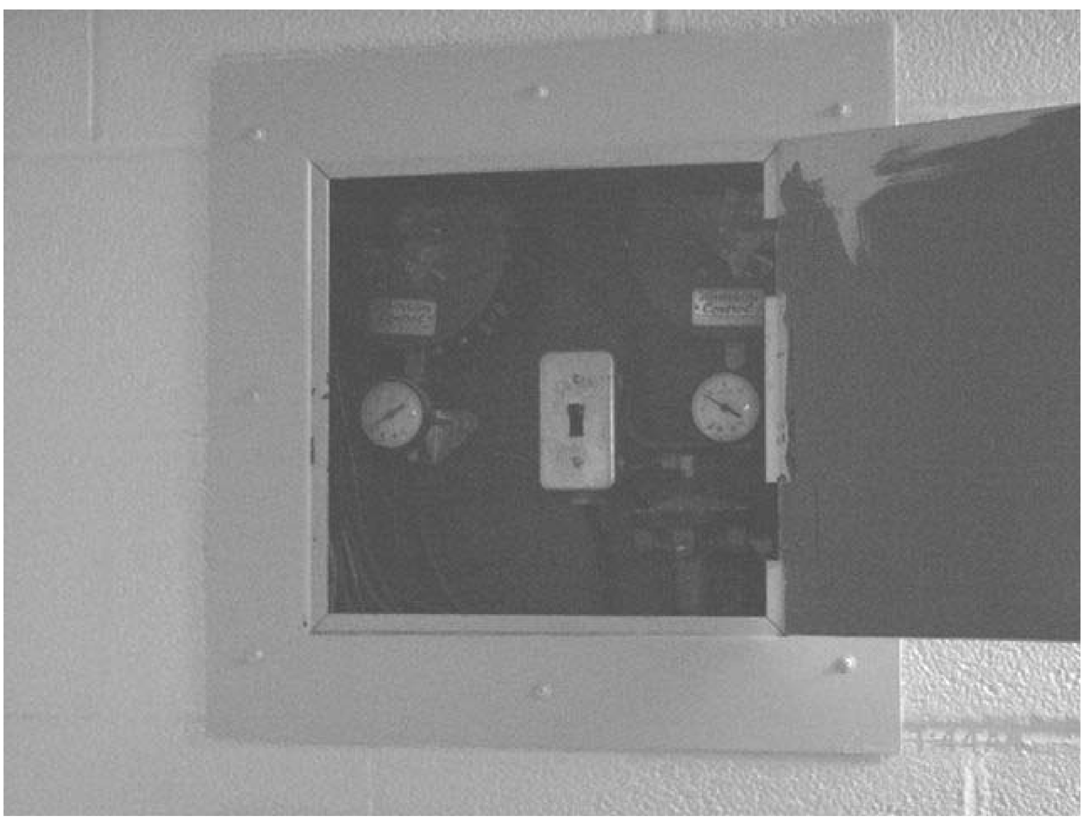


Exhaust Vent in Top of Classroom Coat Closet, Note Dust Build-Up

Picture 5

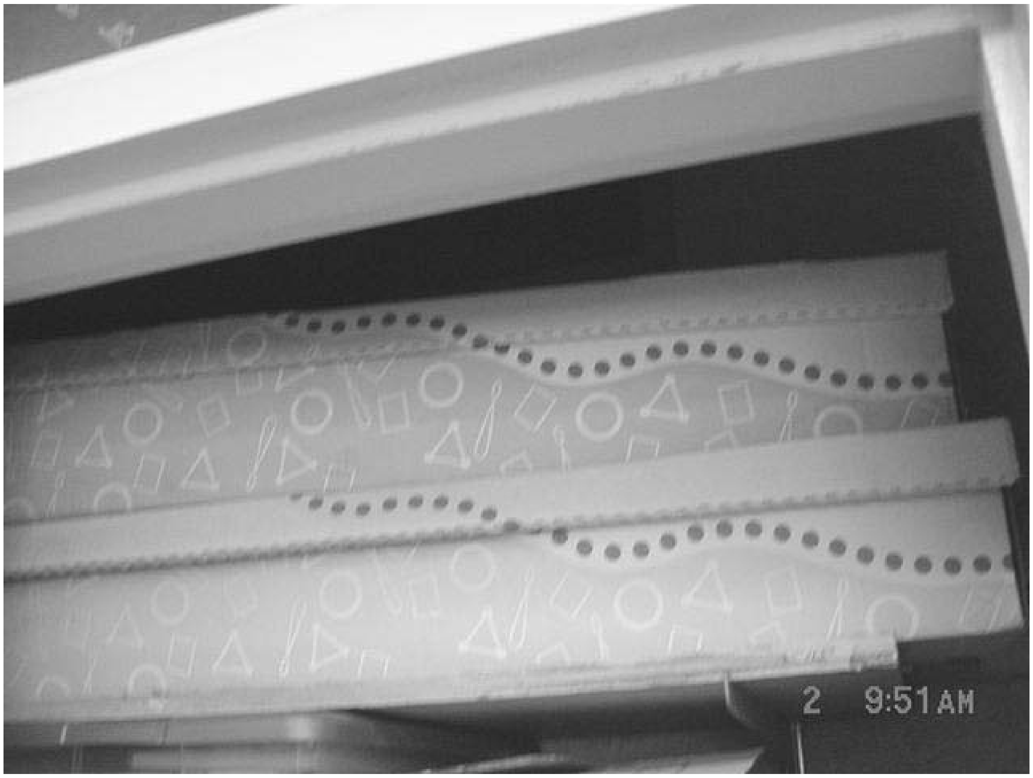
Long-View of Undercut Coat Closet, Note Materials at Bottom Obstructing Airflow

Picture 6



Wall Panel Deactivating Coat Closet Exhaust Vents

Picture 7

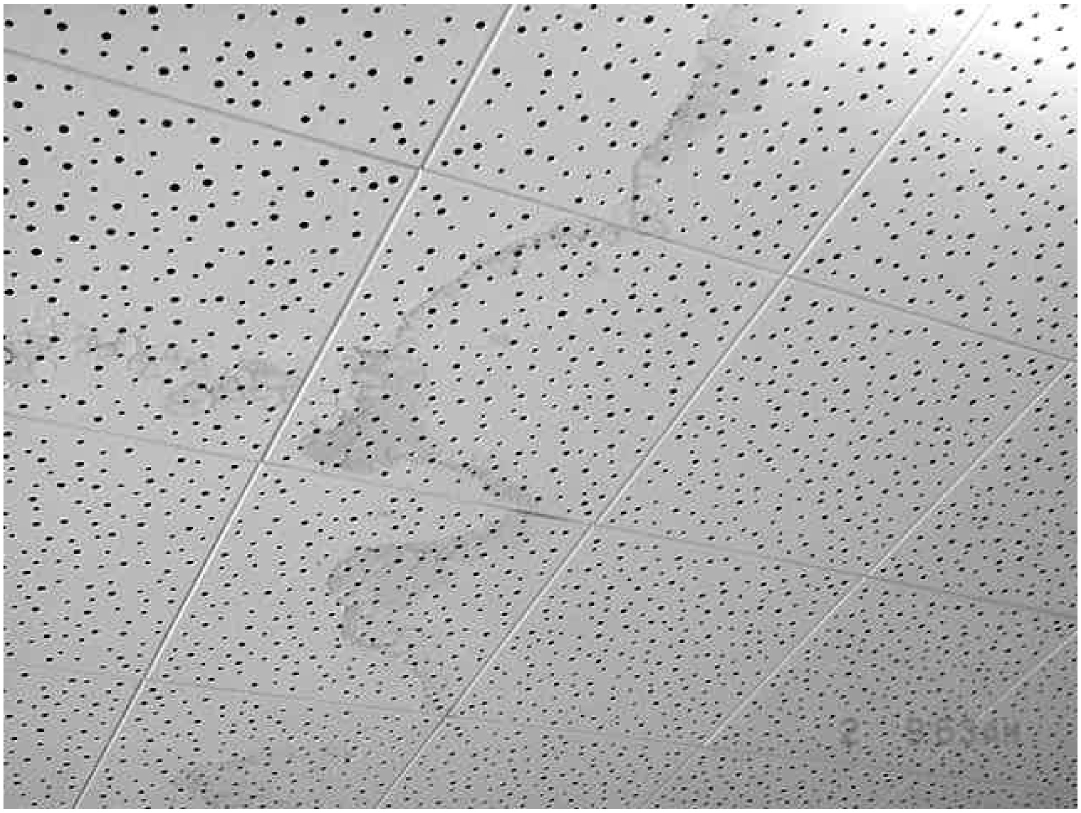


Boxes on Top Shelf of Coat Closet Obstructing Airflow into Coat Closet Exhaust Vent

Picture 8

Small Round Vents Installed in an Attempt to Increase Airflow into Coat Closet Vents

Picture 9



Water Damaged Interlocking Ceiling Tiles

Picture 10

Plant Debris and Bird Seed in Univent Air Intake outside of Classroom 18

Picture 11

Spaces between Exterior Wall Panels (see Picture 13 for Comparison)

Picture 12

Exterior Wall Panel Sealed

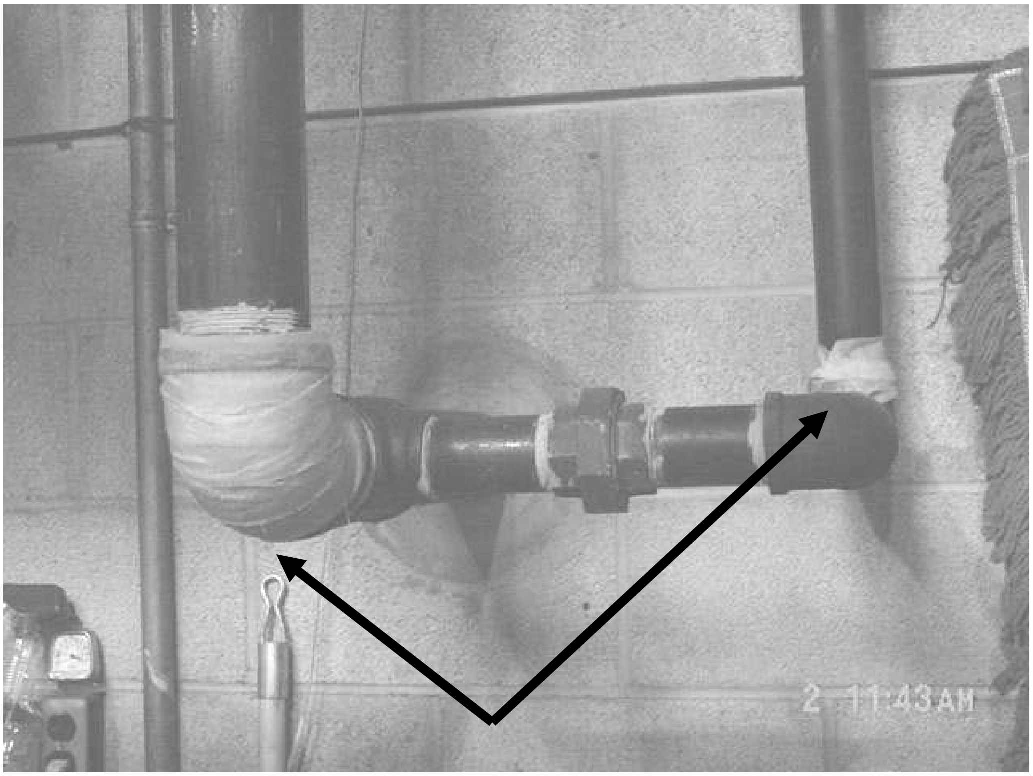
Picture 13

Exterior Wall Crack on Rear of Building

Picture 14

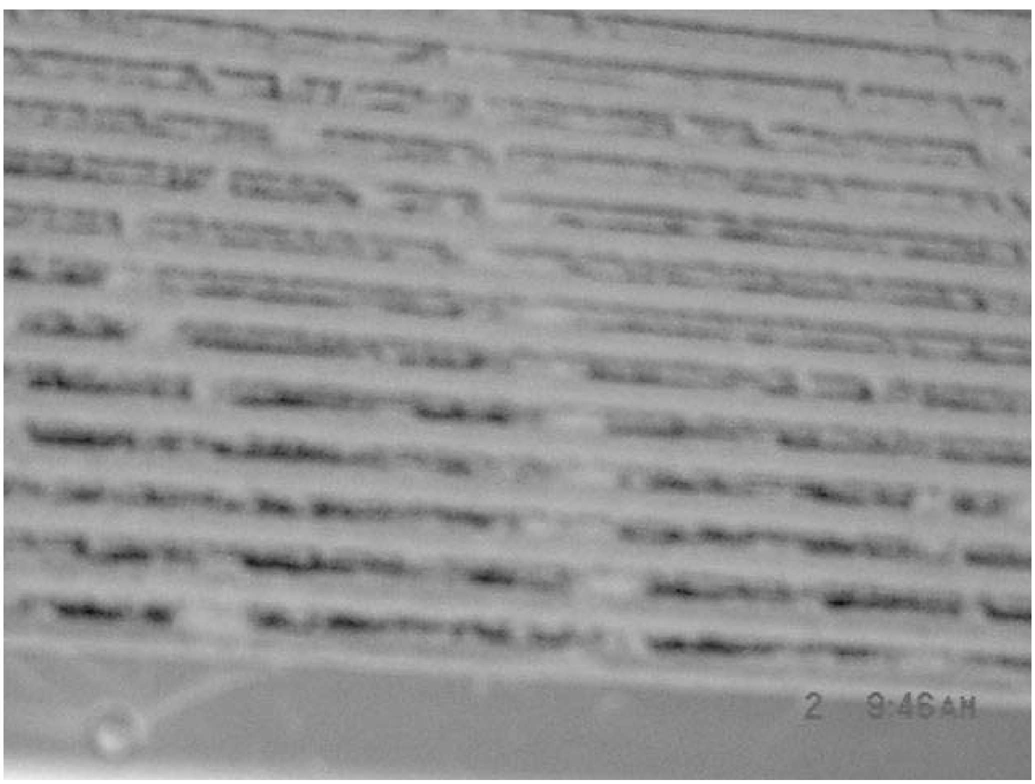
Bird's Nests in Classroom

Picture 15



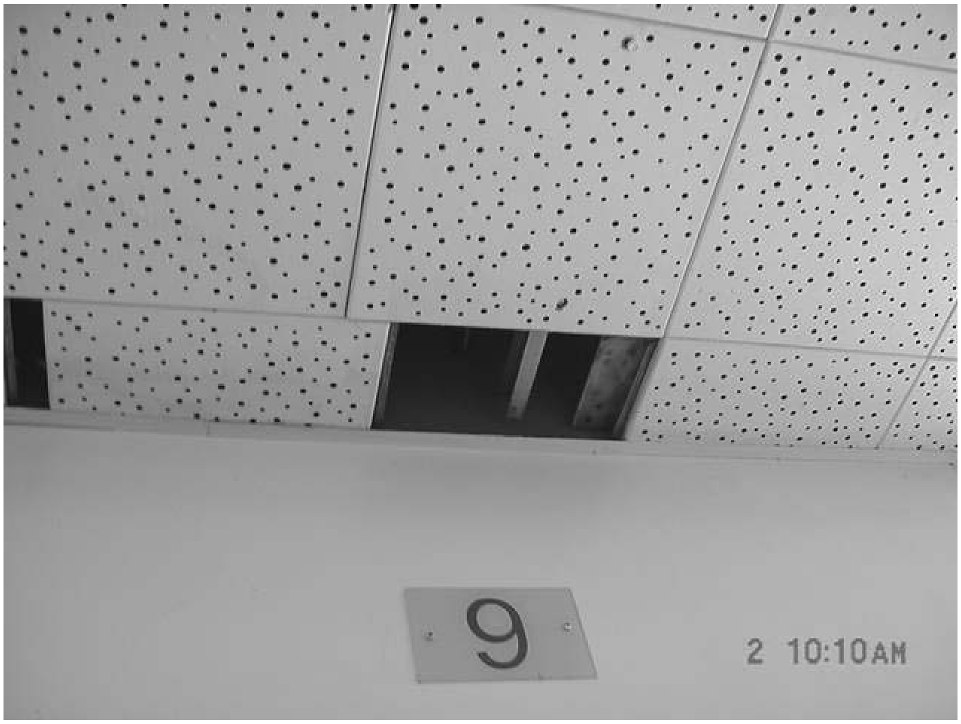
Natural Gas Pipes Sealed by Saugus Building Department

Picture 16



Close-Up of Dust Accumulation on Coat Closet Exhaust Vent

Picture 17



Missing Ceiling Tiles

Picture 18

Tennis Balls on Chair Legs

Picture 19

"Glides" for Chair Legs that can be used as an Alternative to Tennis Balls

Oaklandvale School

266 Main Street, Saugus, MA 01906

Table 1

Indoor Air Results

Date: 05/02/2006

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background	0	55	98	413	1-3	ND	9	N			windy, moderate to heavy rainfall, moderate to heavy traffic.
Main office	2	69	58	1056	ND	ND	15	N	Y ceiling	N	Hallway DO, Inter-room DO,
Teacher's Lounge	1	69	54	1171	ND	ND	14	N	Y ceiling		Hallway DO, #WD-CT: 10.
9	23	70	51	1883	ND	ND	29	Y # open: 0 # total: 4	Y univent (off)	Y closet (off) dust/debris	Hallway DO, #WD-CT: 10, broken windowpane.
10	24	72	48	1259	ND	ND	24	Y # open: 1 # total: 5	Y univent	Y closet boxes	DEM.
11	24	73	48	1589	ND	ND	19	Y # open: 0 # total: 5	Y univent (weak) plant(s)	Y closet (off)	#WD-CT: 7, DEM.
1	20	76	41	1333	ND	ND	17	Y # open: 0 # total: 4	Y univent	Y closet	#WD-CT: 8, DEM.

ppm = parts per million	AT = ajar ceiling tile	design = proximity to door	NC = non-carpeted	sci. chem. = science chemicals
µg/m3 = micrograms per cubic meter	BD = backdraft	FC = food container	ND = non detect	TB = tennis balls
	CD = chalk dust	G = gravity	PC = photocopier	terra. = terrarium
AD = air deodorizer	CP = ceiling plaster	GW = gypsum wallboard	PF = personal fan	UF = upholstered furniture
AP = air purifier	CT = ceiling tile	M = mechanical	plug-in = plug-in air freshener	VL = vent location
aqua. = aquarium	DEM = dry erase materials	MT = missing ceiling tile	PS = pencil shavings	WP = wall plaster

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%

Oaklandvale School

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									Supply	Exhaust	
2	17	76	37	1071	ND	ND	9	Y # open: 0 # total: 5	Y univent	Y closet	
3	15	76	37	1103	ND	ND	11	Y # open: 0 # total: 5	Y univent	Y closet	Hallway DO, #WD-CT: 15, #MT/AT: 1, DEM.
4	16	76	39	1344	ND	ND	16	Y # open: 0 # total: 3	Y univent plant(s)	Y closet	Hallway DO, TB.
boiler room	0	72	40	672	ND	ND	16	N	Y	N	slight gas odors-fittings temporarily sealed by town maint staff.
5	9	73	48	1739	ND	ND	23	Y # open: 0 # total: 4	Y univent (weak)	Y closet (off)	Hallway DO, exhaust reactivated by town electrician.
6	16	72	43	1201	ND	ND	14	Y # open: 0 # total: 5	Y univent	Y closet	Hallway DO,
7	22	73	43	1088	ND	ND	14	Y # open: 1 # total: 5	Y univent plant(s)	Y closet (off)	Hallway DO, #WD-CT: 15, UV-noise, Ex-backdrafting.

ppm = parts per million
µg/m3 = micrograms per cubic meter

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aqua. = aquarium

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
8	24	72	41	1037	ND	ND	18	Y # open: 1 # total: 4	Y univent	Y closet (off) items	Hallway DO, #WD-CT: 10, DEM, TB.
cafeteria	22	72	41	1045	ND	ND	8	N	Y wall	Y wall (off)	Hallway DO, teacher appreciation day-kids eating in classrooms.
12	23	75	43	1515	ND	ND	14	Y # open: 0 # total: 4	Y univent	Y closet	Hallway DO,
library	0	73	38	1023	ND	ND	10	N	Y ceiling	N	Hallway DO,

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

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%