INDOOR AIR QUALITY ASSESSMENT

Central Tree Middle School
281 Main Street
Rutland, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
September 2005

Background/Introduction

At the request of local constituents and the office of Representative Lewis Evangelidis, the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at the Central Tree Middle School (CTMS), 281 Main Street, Rutland, Massachusetts. On May 24, 2005, Cory Holmes, an Environmental Analyst for CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted an assessment of the CTMS.

The CTMS is a red brick building that was constructed in 1997-1998. The building consists of a two-story classroom wing (A-building) and a single-story wing (B-building) that includes a gymnasium, cafeteria/auditorium, media center and administrative offices. Windows are openable throughout the building.

Methods

MDPH staff conducted 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 Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). MDPH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 500 students in fifth through eighth grade and approximately 40 staff members. Tests were taken during normal operations at the school and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in seven of thirty-three areas surveyed, indicating adequate air exchange in the majority of areas surveyed. Fresh air in classrooms is mechanically supplied by a computer-programmed unit ventilator (univent) system (Picture 1). A univent draws air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and returns air through an air intake located at the base of the unit. Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit (Figure 1). Univents were found activated in all classroom surveyed. Obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks located in front of univent returns, were seen in a few classrooms (Pictures 1 and 3). In order for univents to provide fresh air as designed, units must be allowed to operate and remain free of obstructions.

Exhaust ventilation in most classrooms is provided by ducted, grated wall or ceiling vents powered by rooftop motors (Pictures 4 and 5). These vents were also operating during the assessment. However, the location of some vents can limit exhaust efficiency. In several rooms, exhaust vents are located near hallway doors (Picture 4). Exhaust vents in these rooms will tend to draw air from both the hallway and the classroom, reducing the effectiveness of the exhaust vent to remove common environmental pollutants.

Mechanical ventilation in some interior rooms, office space and common areas such as the gymnasium, media center and cafeteria is provided by rooftop air-handling units (AHUs) connected to ceiling or wall-mounted air diffusers via ductwork. Return air is drawn into wall or ceiling exhaust vents and ducted back to the AHUs (Pictures 6 and 7). These systems were all operating during the assessment.

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 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 HVAC systems be re-balanced every five years (SMACNA, 1994). The last date of balancing of the school's mechanical ventilation systems reportedly occurred during the summer of 2004.

The Massachusetts Building Code requires that each room has 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 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, please consult Appendix A.

Temperature measurements ranged from 70^{o} F to 74^{o} F, which were within the MDPH comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measurements in the building ranged from 35 to 41 percent, which were slightly below or at 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 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

Several areas had water-damaged ceiling tiles, which can indicate leaks from the roof or plumbing system (Picture 8/Table 1). Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired. Repeated water damage to porous building materials (e.g., wallboard, ceiling tiles, carpet) can result in microbial growth. The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend 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.

Several classrooms contained a number of plants. In several classrooms, plants were found near the air stream of univents (Picture 9). Plants, soil and drip pans can serve as sources of mold growth, and thus should be properly maintained. Plants should have drip pans to prevent wetting and subsequent mold colonization of window frames. Plants should also be located away from univents and ventilation sources to prevent aerosolization of dirt, pollen or mold.

Plants were observed growing against exterior walls and in front of univent air intakes (Picture 10). A green film of plant debris and/or mold was observed on several of these air intakes (Picture 11). The close proximity of the shrubbery to the air intakes can allow plant debris, pollen, moisture and/or mold to be drawn in to the ventilation system and distributed by the univent. In addition, the growth of roots against exterior walls can bring moisture in contact with the foundation. Plant roots can eventually penetrate, leading to cracks and/or fissures in the sublevel foundation. Over time, this process can undermine the integrity of the building envelope, providing a means of water entry into the building via capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001).

A number of aquariums and terrariums were located in classrooms. Aquariums should be properly maintained to prevent microbial/algae growth, which can emit unpleasant odors. Similarly, terrariums should be properly maintained to ensure soil does not become a source for mold growth.

Open seams between the sink countertop and wall were observed in several rooms (Picture 12). If not watertight, water can penetrate through the seam, causing water damage. Chronic moisture exposure of porous and wood-based materials can cause these materials to swell and show signs of water damage.

Other IAQ Evaluations

Indoor air quality can also 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, MDPH 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). As discussed, 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 of 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 were non-detect or ND (Table 1). Carbon monoxide levels measured in the school were also ND (Table 1).

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits for particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 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 2 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 3 to 33 $\mu g/m^3$, which were above background levels but well 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 particulates 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. Indoor TVOC concentrations throughout the building were ND (Table 1). Outdoor TVOC measurements 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 TVOC containing products (i.e., the concentration of TVOCs within a classroom when the products are actually in use). While no TVOC levels were measured, materials containing VOCs were present in the school. Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat. Cleaning products were found in unlocked cabinets below sinks and on countertops in a number of classrooms (Picture 13). Cleaning products also contain chemicals that can be irritating to the eyes, nose and throat and should be kept out of reach of students.

Several other conditions that can affect indoor air quality were noted during the assessment. Of note was the amount of materials stored in some classrooms. 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 avoid excessive dust build up. A number of exhaust/return vents were noted with accumulated dust. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles. Dust can be irritating to eyes, nose and respiratory tract.

Bird's and wasp's nests were seen on a classroom windowsill near the air stream of a univent (Picture 14). Nests can contain bacteria and may also be a source of allergenic material. Nests should be placed in re-sealable bags to prevent aerosolization of allergenic material.

Univent filters, which are reportedly changed every three months (four times a year), appeared clean during the assessment (Picture 15). However, two small filters were installed in the units, as opposed to one large properly fitting filter. Since two filters are used, there is a space between the two filters. The space can allow for unfiltered air to bypass the filters and be distributed by the univent fans.

Lastly, in an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 16). 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 VOCs. 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). Consider replacing tennis balls with alternative glides (Picture 17).

Conclusions/Recommendations

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

1. Adjust univent air intakes controls and AHUs to increase the introduction of fresh air in areas where carbon dioxide levels were above 800 ppm (Table 1).
2. Close classroom doors to maximize exhaust function.
3. Use openable windows to facilitate air exchange.
4. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
5. Balance mechanical ventilation equipment every five years, as recommended by ventilation industrial standards (SMACNA, 1994).
6. Continue to change filters for HVAC equipment as scheduled.
7. Purchase appropriately sized filters for univents to prevent filter bypass.
8. 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. Drinking water during the day can

help ease some symptoms associated with a dry environment (throat and sinus irritations).

9. Ensure roof/plumbing leaks are repaired. Once leaks are repaired, replace water damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
10. Clean and maintain aquariums and terrariums to prevent mold growth and associated odors.
11. Remove plants from the wall/tarmac junction around the perimeter of the building.
12. Clean and disinfect univent fresh air intake louvers with an appropriate antimicrobial. Ensure univents are *deactivated* prior to cleaning.
13. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Keep plants away from the air stream of univents.
14. Seal areas around sinks to prevent water damage to the interior of cabinets and adjacent wallboard.
15. 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.
16. Clean exhaust/return vents periodically to prevent excessive dust build-up.
17. Store cleaning products properly and out of reach of students. Ensure spray bottles are properly labeled in case of emergency.
18. Store nests in re-sealable bags to prevent aerosolization of irritants, or bring in on an as-needed basis.

19. Consider discontinuing the use of tennis balls on furniture and replacing tennis balls with alternative "glides" (Picture 17).

20. Consider adopting the US EPA (2000b) document, *Tools for Schools*, in order to provide self-assessment and maintain a good indoor air quality environment. The 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. Copies of these materials are located on the MDPH's website: http://mass.gov/dph/indoor_air

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Picture 1

Classroom Univent, Note Books on Air Diffuser

Picture 2

Univent Fresh Air Intake

Picture 3

Classroom Univent Obstructed by Various Materials on and in front of Unit

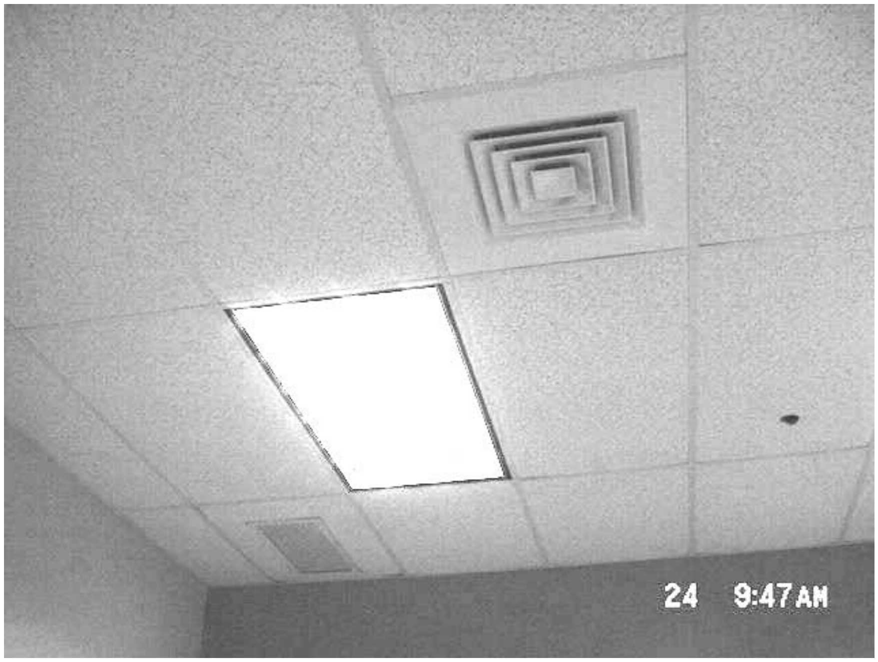
Picture 4

Ceiling-Mounted Exhaust Vent in Classroom, Note Proximity to Open Hallway Door

Picture 5

Wall-Mounted Exhaust Vent

Picture 6



Supply and Return Vent Ducted to Rooftop AHU

Picture 7

Ducted Supply and Return Vents in Gymnasium

Picture 8

Water Damaged Ceiling Tiles in Classroom

Picture 9

Plants Near the Air Stream of Univents

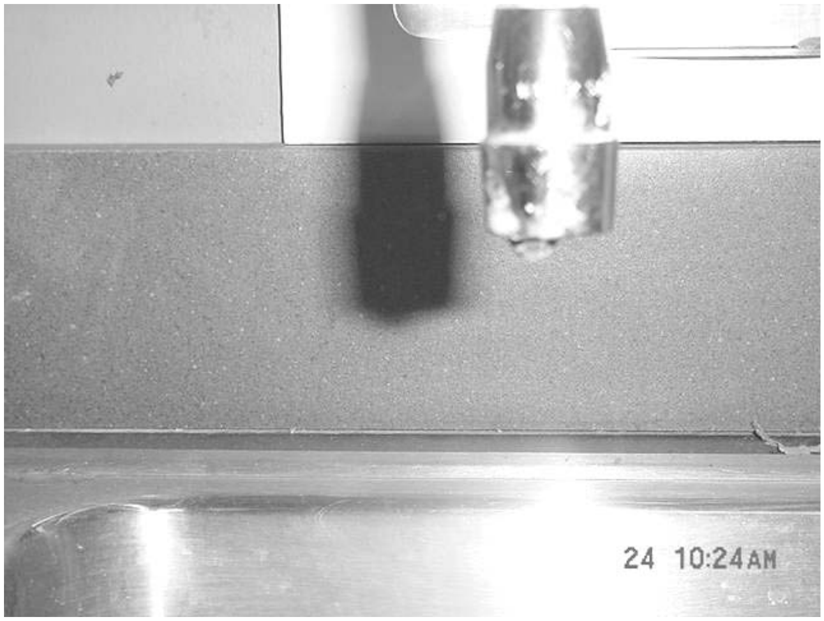
Picture 10

Plants/Shrubbery Growing against Exterior Walls

Picture 11

Plant Debris/Mold on Univent Fresh Air Intakes Louvers

Picture 12



Space between Sink Countertop and Backsplash

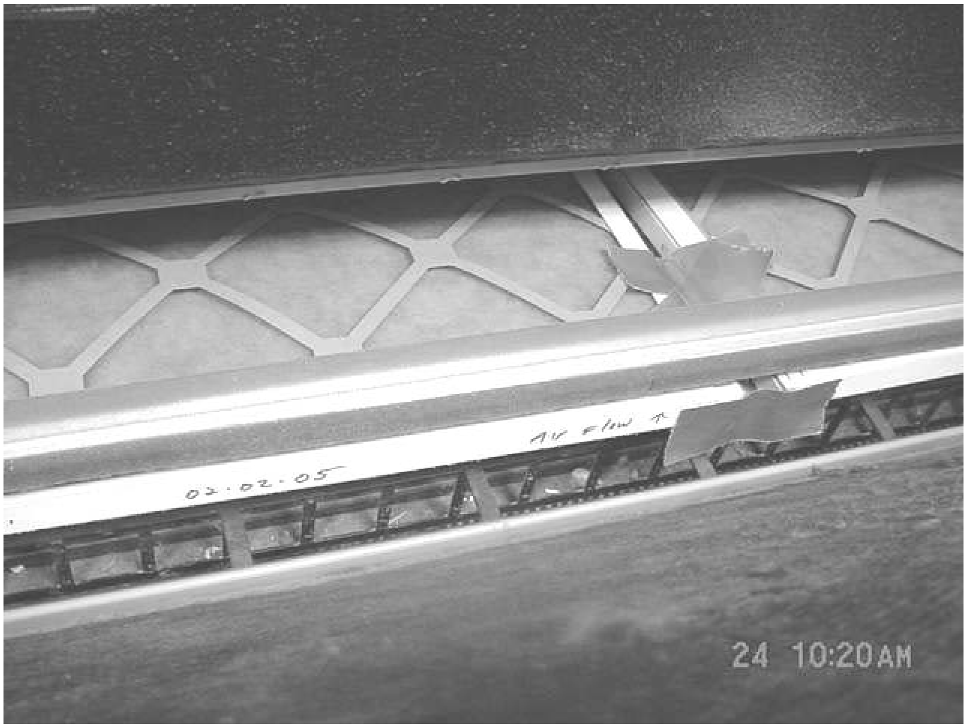
Picture 13

Aerosol Cans and Spray Bottles of Cleaning Products under Classroom Sink

Picture 14

Birds' and Wasps' Nests near Univent Air Diffuser

Picture 15

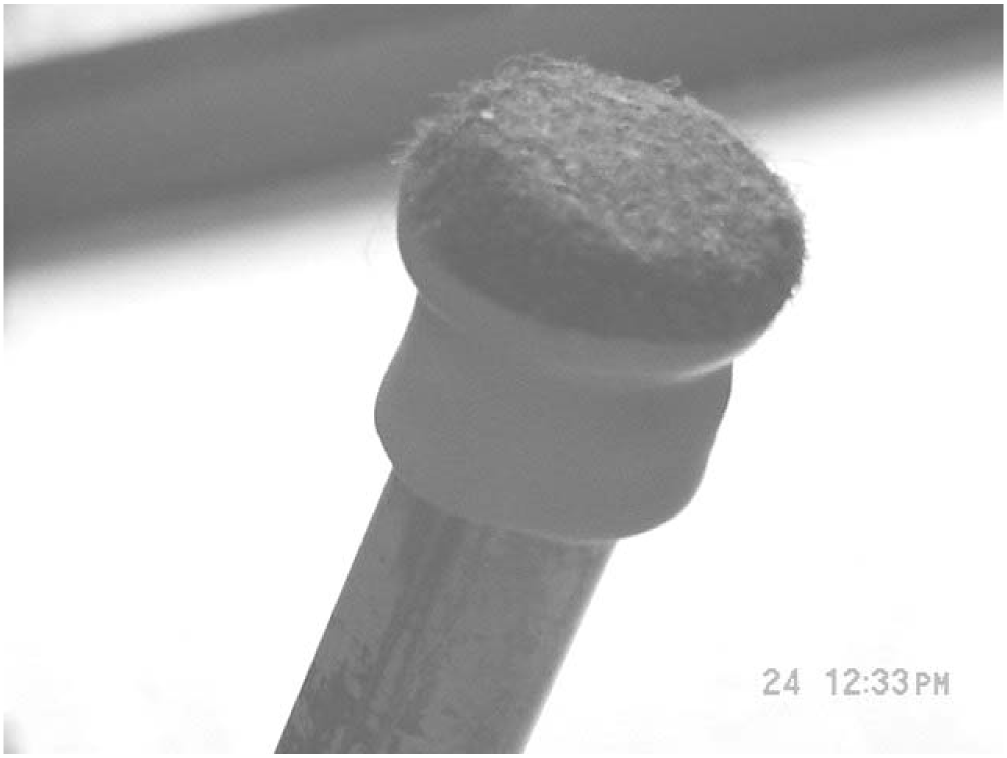


Univent Filters, Note Duct Tape between Filters

Picture 16

Tennis Balls on Chair Legs in Classroom

Picture 17



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

Central Tree Middle School

281 Main Street, Rutland, MA 01843

Indoor Air Results

May 24, 2005

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
background	0	48	60	318	ND	ND	2	N # open: 0 # total: 0			Comments : moderate to heavy rain, cloudy, NE winds 10-15 mph.
234	10	70	40	606	ND	ND	3	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM.
233	15	71	41	718	ND	ND	6	Y # open: 0 # total: 4	Y univent	Y ceiling	breach sink/counter, DEM, plants.
206	20	71	38	656	ND	ND	4	Y # open: 0 # total: 4	Y univent items	Y ceiling	Hallway DO, DEM.
207	19	72	38	713	ND	ND	7	Y # open: 0 # total: 4	Y univent	Y	Hallway DO, DEM, plants.

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
WD = water damage
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%

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									Supply	Exhaust	
208	0	72	37	481	ND	ND	3	N # open: 0 # total: 0	Y univent	Y ceiling	Inter-room DO, #WD-CT : 1.
209 team room	0	72	37	483	ND	ND	3	N # open: 0 # total: 0	Y ceiling	Y ceiling	DEM.
231	20	72	37	666	ND	ND	3	Y # open: 0 # total: 4	Y univent	Y ceiling	DEM.
212	16	71	36	531	ND	ND	4	Y # open: 0 # total: 2	Y ceiling	Y ceiling	Hallway DO, kiln, DEM.
213	20	73	37	622	ND	ND	8	Y # open: 0 # total: 2	Y ceiling		Hallway DO,

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									Supply	Exhaust	
tech store room	0	73	37	561	ND	ND	4	N # open: 0 # total: 0	Y	Y ceiling	Hallway DO, #WD-CT : 5.
228	21	73	37	636	ND	ND	4	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, #WD-CT : 3, DEM, nests.
218	24	72	37	842	ND	ND	5	Y # open: 0 # total: 4	Y univent	Y ceiling	DEM, plants.
219	25	70	38	828	ND	ND	5	Y # open: 0 # total: 0	Y univent	Y	plants.
220	7	71	40	936	ND	ND	15	Y # open: 0 # total: 2	Y	Y	Hallway DO,

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216	0	71	37	635	ND	ND	10	N # open: 0 # total: 0	Y ceiling	Y ceiling	PC.
227	5	73	38	715	ND	ND	9	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM.
226	14	72	37	722	ND	ND	10	Y # open: 0 # total: 4	Y univent	Y ceiling	#WD-CT : 1, DEM.
106	23	72	38	786	ND	ND	4	Y # open: 0 # total: 4	Y univent	Y wall	DEM, items.
107	22	72	38	866	ND	ND	12	Y # open: 0 # total: 4	Y univent	Y wall	items.

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M = mechanical
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ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
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WD = water damage
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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%

Central Tree Middle School **Indoor Air Results**

281 Main Street, Rutland, MA 01843 **Table 1** **May 24, 2005**

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	
109	0	72	36	581	ND	ND	5	N # open: 0 # total: 0	Y ceiling	Y ceiling	Hallway DO,
134	20	72	38	772	ND	ND	7	Y # open: 0 # total: 4	Y univent items	Y wall	Hallway DO, breach sink/counter, TB, cleaners.
133	20	72	38	765	ND	ND	9	Y # open: 0 # total: 4	Y univent	Y wall	Hallway DO, DEM.
131	19	72	39	775	ND	ND	10	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, aqua/terra, cleaners.
129	25	72	39	798	ND	ND	19	Y # open: 0 # total: 4	Y univent	Y ceiling dust/debris	Hallway DO, DEM, aqua/terra.

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

AD = air deodorizer
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aqua. = aquarium

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May 24, 2005

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	
127	17	71	38	787	ND	ND	13	Y # open: 0 # total: 4	Y univent	Y wall	Hallway DO, breach sink/counter, aqua/terra.
126	13	72	38	754	ND	ND	13	Y # open: 0 # total: 4	Y univent	Y wall	Hallway DO, breach sink/counter, PF.
media center	15	73	35	458	ND	ND	4	Y # open: 0 # total: 7	Y ceiling	Y ceiling wall	
112	10	73	37	546	ND	ND	8	N # open: 0 # total: 0	Y ceiling	Y ceiling	Hallway DO, DEM.
Music	20	73	39	1093	ND	ND	33	Y # open: 0 # total: 4	Y ceiling	Y ceiling	DEM.

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practice room	0	73	38	980	ND	ND	13	Y # open: 0 # total: 1	Y ceiling	Y ceiling	Hallway DO,
cafeteria	150	72	40	890	ND	ND	8	N # open: 0 # total: 0	Y ceiling	Y ceiling	Hallway DO,
kitchen/dishroom	4	73	40	651	ND	ND	6	N # open: 0 # total: 0	Y ceiling	Y ceiling	Hallway DO, Comments : cooking appliances/dishwasher.
gym	14	74	37	610	ND	ND	13	N # open: 0 # total: 0	Y ceiling	Y ceiling	

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