INDOOR AIR QUALITY ASSESSMENT

Malden Government Center
200 Pleasant Street
Malden, Massachusetts

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

At the request of Chris Webb, Director of the Malden Health Department (MHD), an indoor air quality assessment was conducted at Malden Government Center (MGC), 200 Pleasant Street, Malden, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH). Complaints of shortness of breath and respiratory concerns from employees in the building department on the second floor prompted the request.

On May 11, 2005, a visit was made to this building by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, to conduct an indoor air quality assessment. Mr. Holmes was accompanied for portions of the assessment by Rich Tiley, Inspector, MHD; Peter San Angelo, MGC maintenance department and Mr. Webb. MGC is a six-story brick building that was constructed in the late 1960s early 1970s. MGC contains city offices, public meeting rooms, a cafeteria/kitchen, the Malden School Department, and the Malden Senior Center.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

MGC offices have a population of approximately 100 employees and can be visited by several hundred members of the public daily. The tests were taken under normal operating conditions and appear in Table 1.

Discussion

Ventilation

It can be seen from the Table 1 that carbon dioxide levels were below 800 parts per million [ppm] parts of air in all areas surveyed, with one exception, the business manager's office, indicating adequate air exchange throughout the building. It is important to note that a number of areas were unoccupied, sparsely populated and/or had windows open, which can greatly reduce carbon dioxide levels. Therefore carbon dioxide levels would be expected to be higher with increased occupancy and/or with windows shut.

Ventilation is provided by a heating, ventilation and air-conditioning (HVAC) system. Air handling units (AHUs) located in a mechanical room on the sixth floor provide fresh conditioned air. The AHUs draw air from the outside through an air intake (Picture 1). Air is then filtered, heated or cooled then supplied to occupied areas through round floor vents or air diffusers (Pictures 2 and 3) located around the perimeter of the building. Return air is drawn into a ceiling plenum through slots around lighting fixtures (Picture 4) and drawn back to the AHUs via ductwork.

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. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994). The date of the last balancing of these systems reportedly occurred approximately five years ago.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (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 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. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings ranged from 75° to 82° F, indicating that some rooms were above the MDPH recommended guidelines in several areas (Table 1). The MDPH recommends that indoor air temperatures be maintained in a range of 70° to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Complaints of uneven heating and cooling were expressed in areas throughout the building. Many areas are reportedly difficult to maintain comfortable temperatures due to solar radiation through the large plate glass window systems or drafty window panes. In the school department office windows were sealed with duct tape reportedly to keep out drafts (Picture 5).

Relative humidity measurements ranged from 35 to 43 percent, which were within or slightly below the lower end of the MDPH recommended comfort range in areas surveyed. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. 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 Growth/Moisture Concerns

A number of areas had water damaged ceiling tiles, which can indicate leaks from the roof or plumbing system. Water-damaged ceiling tiles can provide a source for mold growth and should be replaced after a water leak is discovered and repaired. The personnel/retirement area appears to be an area of reoccurring water damage through the building exterior. To collect incoming water a drain/gutter was installed above the ceiling tile system, which drains into the sink in the break room (Pictures 6 and 7). What appeared to be visible mold growth was observed growing inside the clear drainage tube (Picture 8).

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 (e.g., ceiling tiles, carpeting) cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Plants were observed in several areas. Plants, soil and drip pans can serve as sources of mold growth, thus should be properly maintained. Over-watering of plants should be avoided and drip pans should be inspected periodically for mold growth.

Other IAQ Evaluations

The process of combustion produces a number of pollutants, depending on the composition of the material. In general, common combustion emissions can include carbon monoxide, carbon dioxide, water vapor and smoke. Of these materials, carbon monoxide can produce immediate, acute health effects upon exposure. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). Measurable levels of carbon monoxide slightly above background (1-2 ppm) were detected in the hallway outside of the parking garage (Table 1). The door to the parking garage was found propped open during the assessment (Picture 9). When closed, MDPH staff noted spaces around the door that could serve as pathways for exhaust emissions into the building (Picture 10).

Several other conditions were noted during the assessment, which can affect indoor air quality. Exposed insulation that may contain asbestos was observed on pipes in the mechanical room near the kitchen (Pictures 11). Upon discovery, MDPH staff recommended that the material be inspected by a licensed asbestos inspector as soon as practicable. Also noted in this mechanical room were mop buckets with stagnant water, which can provide a source of unpleasant odors, and a propane tank which is a flammable material that should be stored in accordance with National Fire Prevention Agency (NFPA) recommendations (Picture 12).

A number of occupants complained of poor cleaning of carpets, most notably in the Malden School Department. Accumulated dust was also observed on flat surfaces, on ceiling tiles around supply and return vents and on fan blades to personal fans (Pictures 13 through 15). Reactivated fans can serve to distribute accumulated dust. If exhaust vents become deactivated, backdrafting can result in the re-aerosolization of accumulated dust particles. Dust can be irritating to the eyes, nose and respiratory tract.

AHUs are equipped with filters that strain particulates from airflow. The type of filters installed at MGC provide minimal to moderate filtration of respirable dusts (Picture 16). In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop), which can subsequently reduce the efficiency of the AHU due to increased resistance. Prior to any increase of filtration, each AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

Finally, ceiling tiles were missing in several areas exposing fiberglass insulation (Pictures 17). Fiberglass can be a source of eye, skin and respiratory irritation for sensitive individuals. Missing tiles can create pathways for particulates and odors to migrate into occupied areas.

Conclusions/Recommendations

A number of issues often seen in buildings like this, such as design and routine maintenance issues, which can affect indoor air quality, were observed. These factors can be associated with a range of IAQ related health and comfort complaints (e.g., eye, nose, and respiratory irritations). While some problems can be addressed immediately, others may require planning and resources. In view of the findings at the time of the visit, the following recommendations are made to improve general indoor air quality:

1. Ascertain whether the pipe insulation in the basement and sub-basement contains asbestos and encapsulate or remove in conformance with Massachusetts asbestos abatement laws.
2. Change filters for HVAC equipment as per the manufacturer's instructions or more frequently if needed.

3. Consider increasing the dust-spot efficiency of HVAC filters. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.
4. To maximize air exchange the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy.
5. Encourage staff to report any complaints concerning temperature control/preventive maintenance issues to the facilities department.
6. Consult a ventilation engineer concerning re-balancing of the ventilation systems. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
7. Keep all doors accessing the parking garage closed at all times.
8. Ensure doors around the garage fit completely flush with threshold. Seal doors on all sides with foam tape, and/or weather-stripping. Consider installing weather-stripping/door sweeps on both sides of the door with access to the garage to provide a duel barrier. Ensure tightness of doors by monitoring for light penetration and drafts around doorframes.
9. Ensure leaks are repaired and 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. Particular attention should be made to water damaged carpeting. If carpeting is wet repeatedly or becomes mold-colonized consider removing carpeting and replacing with a non porous floor covering.

10. Consult with an architect and or general contractor regarding the integrity of the building envelope, primarily concerning water penetration in the personnel/retirement area.

11. Change tubing for temporary drainage system in the personnel/retirement area. Inspect periodically for microbial growth.

12. 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).

13. Replace missing/damaged ceiling tiles. Clean/replace soiled ceiling tiles (Picture 15).

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

15. Repair/replace broken windows; re-seal loose window frames to prevent drafts and water penetration.

16. Consider cleaning carpeting annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC). Copies of the IICRC fact sheet can be

downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)

17. 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://mass.gov/dph/indoor_air.

References

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US EPA. 2000. National Ambient Air Quality Standards (NAAQS). . US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

Picture 1

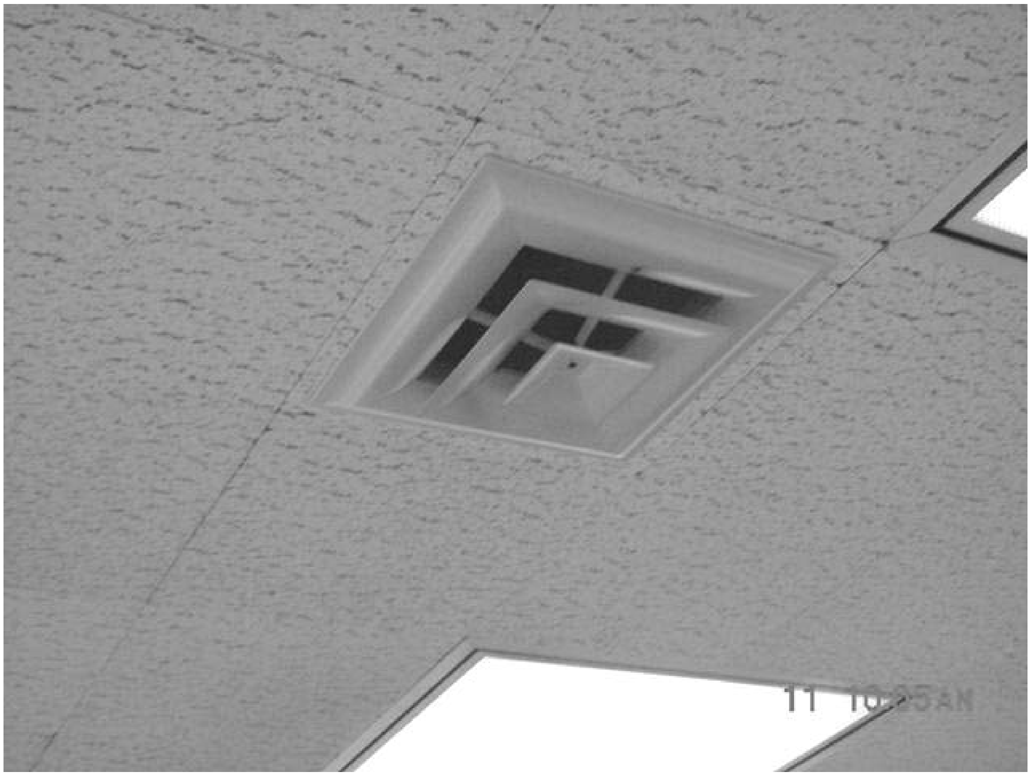
AHU Fresh Air Intake Vents **Outside Air Intake Vents**

Fresh Air Ventilation Duct

Picture 2

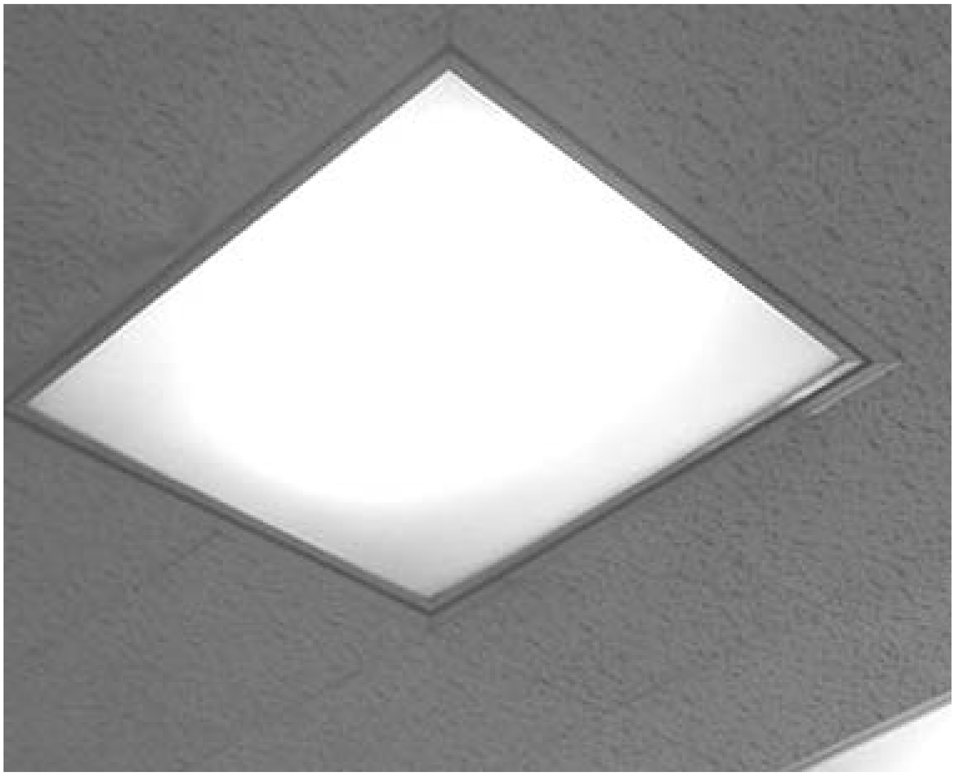
Floor Supply Vents

Picture 3



Ceiling-Mounted Air Diffuser

Picture 4



Slotted Vents around Light Fixtures

Picture 5

Duct Tape around Window Frames in Malden School Department

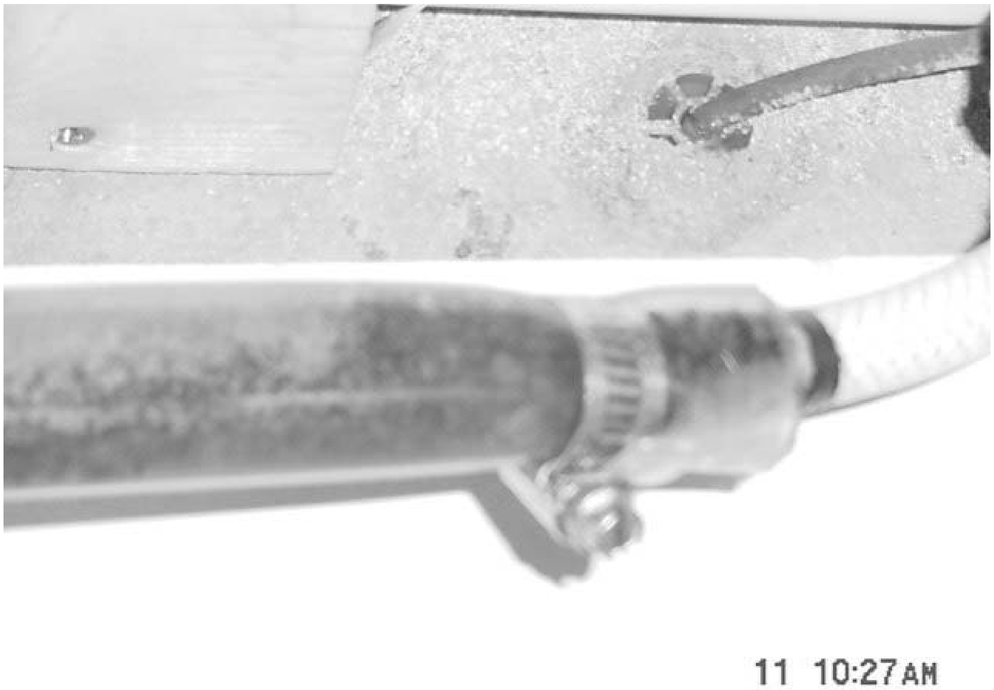
Picture 6

Temporary Drainage System above Ceiling Tiles in the Personnel/Retirement Area, Note Drain at Bottom of Gutter

Picture 7

Terminus of Hose from Temporary Drainage System in Previous Picture

Picture 8



Dark Debris Believed to be Mold Growth in Clear Plastic Tube of Temporary Drainage System in Personnel/Retirement Area

Picture 9

Hallway Accessing the Parking Garage, Note Door to Garage Propped Open

Picture 10

Light Penetrating beneath Parking Garage Door (when closed)

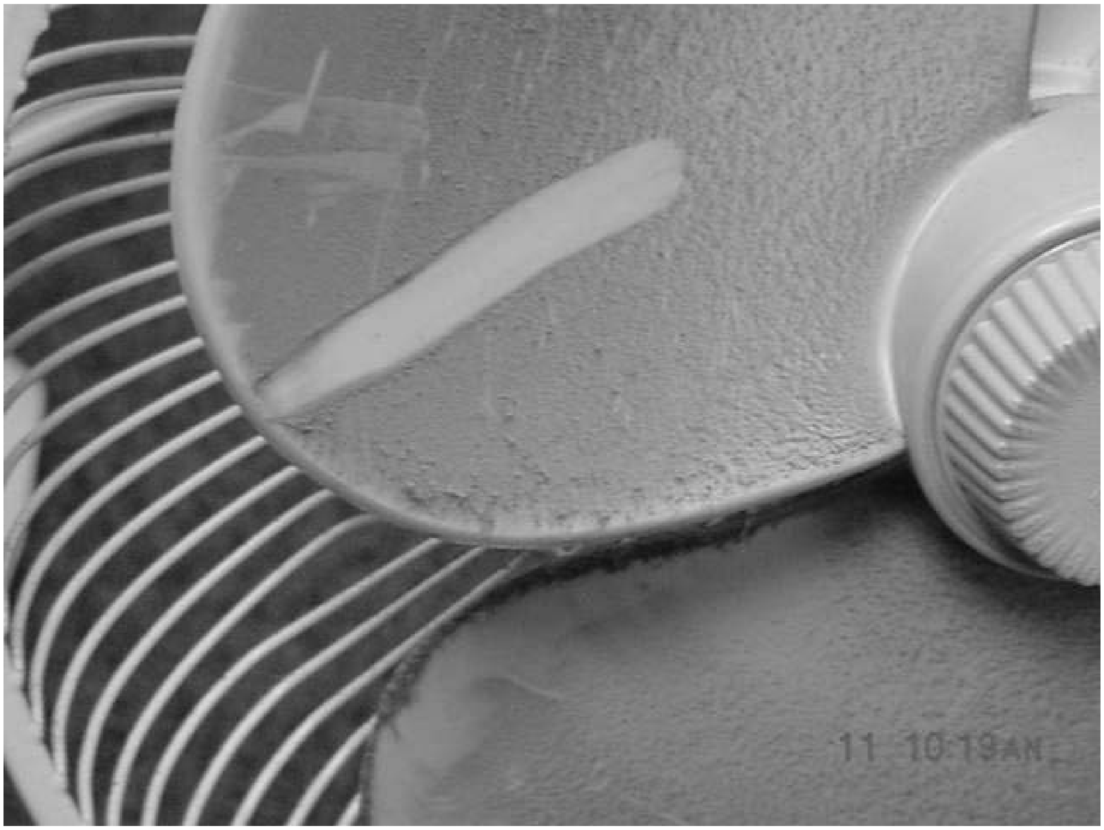
Picture 11

Exposed Insulation Material in Mechanical Room near Kitchen

Picture 12

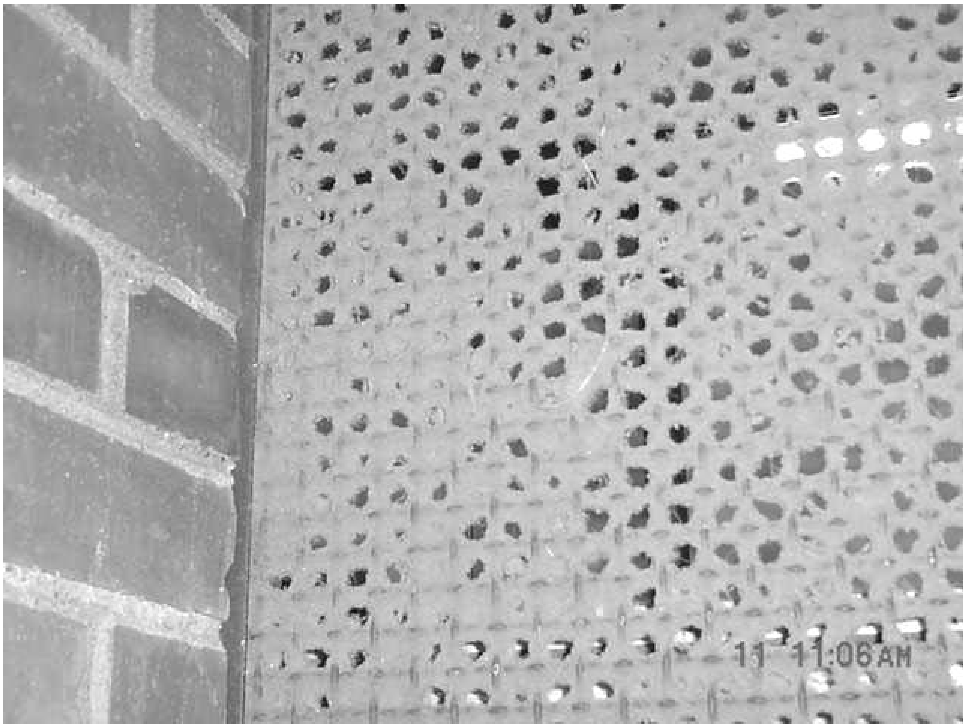
Mop and Buckets in Mechanical Room near Kitchen, also note Propane Tank

Picture 13



Dust Accumulation on Personal Fan Blades

Picture 14



Dust/Debris Accumulation in Passive Air Grate near Kitchen/Cafeteria

Picture 15

Dust/Debris Deposition around Supply Vent in Kitchen/Cafeteria

Picture 16

Fibrous Mesh Filters Installed in AHUs

Picture 17

Missing Ceiling Tiles Exposing Fiberglass Insulation

TABLE 1

Indoor Air Test Results – Malden Government Center May 11, 2005

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
Outside (Background)	347	ND	69	42					Weather conditions: clear, sunny, winds-light and variable
BOH Main reception	457	ND	78	37	3	Y	Y	Y	Radiant heat complaints-afternoon, temperature control issues, window open
Nurse's Office	401	ND	76	37	2	Y	Y	Y	Plants, water damaged CTs/dislodged CTs, window open
BOH Director's Office	412	ND	76	67	0	Y	Y	Y	2 dislodged CTs
Building Department Code Enforce Main Reception	425	ND	77	37	3	Y	Y	Y	
Building Inspector	407	ND	78	38	0	N	Y	Y	Dust accumulation
Copy Room	404	ND	77	38	0	N	Y	Y	Photocopier, 6 missing CT's
Building Dept Center	409	ND	77	37	0	N	Y	Y	

*** ppm = parts per million parts of air**
CTs = ceiling tiles, MTs = missing 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 1-1

TABLE 1

Indoor Air Test Results – Malden Government Center **May 11, 2005**

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
Building Dept East		ND				Y		Y	Exterior door open, plants, water damaged CT's/MTs-exposed fiberglass
Mail Room	431	ND	77	39	2	N	Y	Y	Ceiling vent covered with bag, plants
Building Dept Code	424	ND	76	39	1	N	Y	Y	
Building Inspector	437	ND	76	39	0	N	Y	Y	Dust-personal fan
Personnel/Retirement	412	ND	79	37	3	N	Y	Y	Water damaged CTs along exterior wall, plants
Break room	469	ND	79	37	3	N	Y	Y	gutter/drain into sink (mold growth in tube)
Retirement Director	440	ND	79	36	0	N	Y	Y	
Personnel Director	410	ND	79	36	0	Y	Y	Y	Dust accumulation, window open
File Room	426	ND	79	37	0	N	Y	Y	Photocopier, no local exhaust

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School Department Main	447	ND	76	38	3	Y	Y	Y	Duct tape on windows-drafts, temperature control complaints, MTs, carpet cleaning complaints, dust complaints, window open
Business Manager	808	ND	76	41	1	Y	Y	Y	
Lunch Room	483	ND	75	40	0	Y	Y	Y	WD CTs
Cafeteria side eating area	414	ND	76	44	0	N	Y	Y	AHU Room, former smoking area
Cafeteria	488	ND	77	43	4	N	Y	Y	Dirty/dusty vents
Mechanical Room		ND			0	Y			Filters saturated with dust, exposed pipe insulation, storage of items
Parking Garage Hallway		1-2							Door propped open, spaces under door
City Clerk	391	ND	80	42	2	Y	Y	Y	Window open, plants MTs
City Clerk Office	386	ND	78	41	1	N		Y	Window open

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Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
Engineering Water/Sewer	410	ND	82	35	3	Y	Y	Y	Personal fans, window open
Malden Redevelopment Authority (MRA)	371	ND	80	35	4	Y	Y	Y	Window open, MTs wiring
Finance Department MRA	489	ND	82	37	2	Y	Y	Y	Personal fans, water damaged CTs, window open

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